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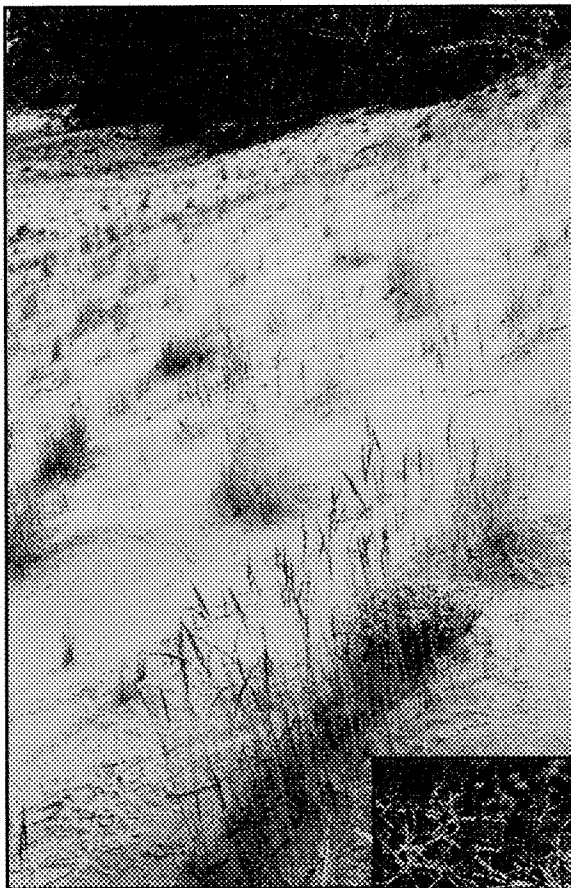
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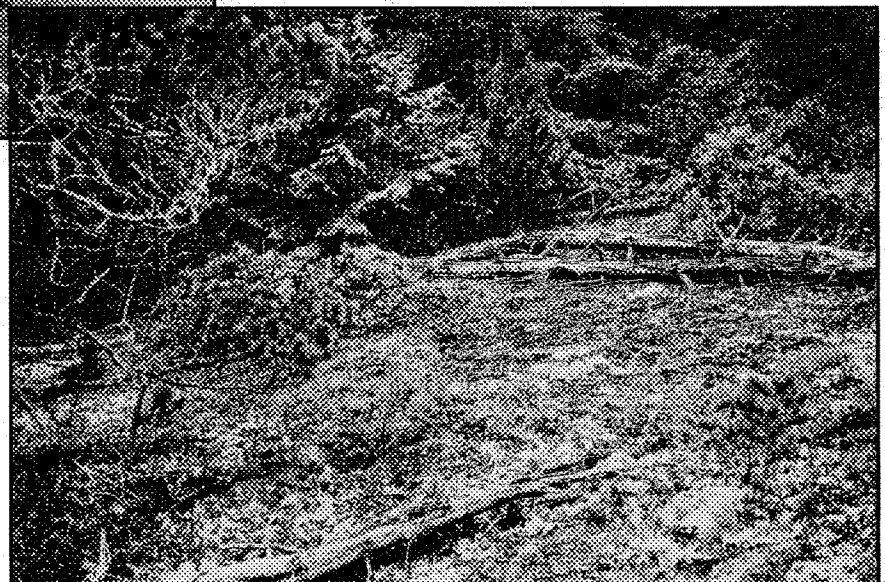
R6-NR-ECOL-TP-09-98



Plant Associations of the Oregon Dunes National Recreation Area



Red fescue association and shore
pine/bearberry association.



**PLANT ASSOCIATIONS
OF THE
OREGON DUNES NATIONAL RECREATION AREA
SIUSLAW NATIONAL FOREST, OREGON**



Minimal differences in movement of sand can influence vegetation: at right, the seashore bluegrass association on slightly shifting sand at the foot of a dune slip face; at left, the red fescue association on relatively stable sand, slowly being buried by the slip face.

by

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and
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Photographs by John Christy

Cover photos: Shore pine/bearberry association and red fescue association.

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SUMMARY

This book is a guide to the plant associations of the Oregon Dunes National Recreation Area. It includes general descriptions of the physical and biological setting of the Recreation Area: its climate, geology, landscape, soils, wildlife, and ecological processes. Analysis of quantitative field data identified 52 plant associations occurring in the Recreation Area, and others surely escaped our detection. Vegetation is classified according to the National Vegetation Classification System (Federal Geographic Data Committee 1996; Anderson et al. 1998; Grossman et al. 1998). Ordination of stand data, and delineation of successional pathways indicate that the vegetation is arranged along gradients of moisture, stand structure, soil development, and successional age. Keys identifying each association are followed by descriptions of each association. Descriptions of each association include acronym, ecoclass code (Hall 1998), environment, vegetation and ecology, succession, distribution and history, management issues, and previous studies. Appendices summarize vegetation data, and list vascular plants known or reported from the Recreation Area.

PREVIOUS WORK

The Oregon Dunes National Recreation Area is well known for its towering dunes, reputedly the largest of their kind in the world, and a seemingly endless expanse of shifting sand. People come from all over the world to see, study, and play in this spectacular landscape. Some people have even tried to farm it.

Many scientists have worked in the Recreation Area, creating a wealth of information which helped in the compilation of this guide. Munger (1910, 1967) conducted the first survey of forest types on the Recreation Area, two years after it was acquired by the Forest Service. House (1914a, 1914b, 1918), Peck (1919) and Cooper (1936) were the first to describe vegetation in and near the Recreation Area. Egler (1934), while assisting Cooper in the field, gathered data and wrote the first account of vegetation ecology in the Recreation Area. Cooper's (1958) monograph of the structural features, history and ecology of the dunes remains the definitive reference for any work on the Recreation Area. Kumler (1963, 1969) was the first to describe the forest associations of the Recreation Area in any detail. Wiedemann (1966, 1984, 1993), Wiedemann et al. (1969), and Wiedemann and Pickart (1996) produced a series of comprehensive overviews of dune ecology in the Recreation Area and elsewhere along the Pacific coast. Leuthner (1969) studied the lichen flora of dunes in the Florence area, including two sites in the Recreation Area at Cleawox Lake and Carter Lake. Pinto et al. (1972) provided descriptions, including useful site-specific information, in a planning document for the newly-created Recreation Area. Lund (1973) wrote a brief description of dune landforms, based on the earlier work of Cooper (1958). Newman (1974, 1983) studied dynamics of deflation plains between Carter Lake and Tahkenitch Creek. Wilde (1982), while working in the Sutton Creek dune sheet just north of the Recreation Area, documented changes caused by the advent of European beachgrass -- processes also occurring within the boundaries of the Recreation Area. Quayle (1982) described several Sitka spruce associations from headlands north of the Recreation Area. Hemstrom and Logan (1986) focused most of their work on forests farther inland, but provided descriptions for some of the forest associations on the Recreation Area. Pilz et al. (1996) and Hosford et al. (1997) are investigating the productivity of commercially-valuable matsutake mushrooms in different habitats on the Recreation Area, and monitoring the response of matsutake to different harvest regimes. McCune et al. (1997) reported several rare lichens from the Recreation Area, collected at Eel Creek and Carter Lake.

LOCATION

The Recreation Area, a district of the Siuslaw National Forest, is located on the central coast of Oregon. It spans 40 miles of the Coos Bay dune sheet, from Coos Bay in the south to Florence in the north, between approximately 43°30' N and 44°N latitude. The Recreation Area averages about 1.5 miles in width, extending up to 3 miles inland (Fig. 1). It encompasses some 31,500 acres of dunes, forest and wetlands, spanning the western portions of Lane, Douglas and Coos counties. Elevation ranges from sea level to about 600 feet.

CLIMATE

The climate of the Recreation Area is both maritime and Mediterranean, being influenced by the Pacific Ocean. Temperatures are moderate year-round. Most precipitation occurs in winter months, followed by summer drought (Fig. 2). Mild winter temperatures permit a growing season throughout most of the year (Patching 1987; Haagen 1989). Between October and April, low-pressure weather systems generated in the Gulf of Alaska bring extended and occasionally violent cyclonic storms to the coast. These winter storms bring heavy rains, accounting for 80 percent of the year's total precipitation, and strong south to southwesterly winds. High-pressure atmospheric conditions may develop in winter, producing periods of cold, clear weather and frost. Snow is rare on the Recreation Area, but not uncommon in the adjacent Coast Range above 2,500 feet elevation. By mid-June, a high pressure system with north to northwesterly winds develops off the coast, deflecting storms to the north and maintaining clear skies. Summer precipitation is negligible, and may not occur for weeks at a time. On hot days, marine fogs occur along the immediate coast, causing cool temperatures up to a mile or two inland. The high pressure system breaks down in September, bringing an end to summer drought.

Along this area of the Pacific coast, precipitation increases gradually with increasing latitude, and temperatures become cooler (Cooper 1958; Wiedemann et al. 1969; Loy 1976). However, the moderating maritime influence diminishes abruptly only a few miles inland, and the cooling coastal fogs of summer penetrate the Coast Range only along the larger rivers. Weather stations at North Bend and Canary, the latter five miles southeast of Florence, show relatively little variation in seasonal average temperature, but both maximum and minimum temperatures become more extreme at Canary (Table 1).

Table 1. Average seasonal temperatures (°F) at North Bend and Canary.

	Ave. winter	Ave. winter minimum	Ave. summer	Ave. summer maximum
North Bend	46	40	59	65
Canary	45	38	60	76

While precipitation increases with latitude, it also increases with elevation in the Coast Range. Precipitation on the Recreation Area averages 65-70 inches per year, but it may reach 100 inches 10-20 miles inland. In November 1983, Florence received 15.95 inches of rain, while a ridge 10 miles inland received 22.02 inches in the same period (Hemstrom and Logan 1986). Cooper (1958) reported only 47 clear days in one year, the balance with fog on 58 days, rain on 68, cloud and fog on 78 and cloud on 115.

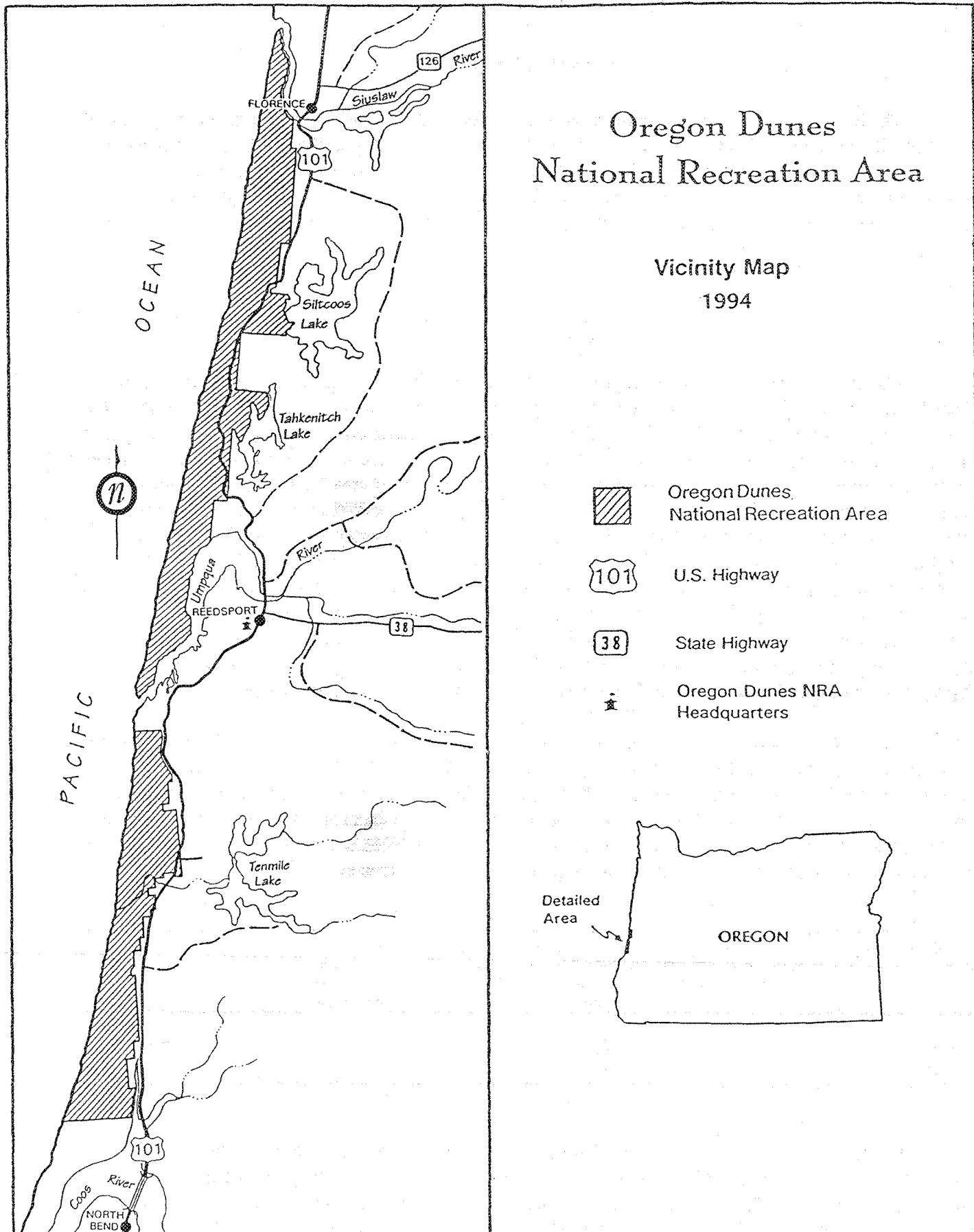


Fig. 1. Location map, Oregon Dunes National Recreation Area.

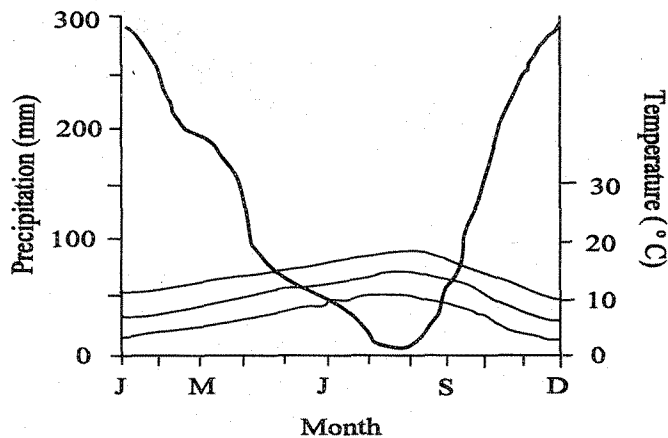


Fig. 2. Temperature and precipitation records for North Bend, at the southern end of the Oregon Dunes National Recreation Area (after Loy 1976).

GEOLOGY

The geology of the northwest coast of North America was reviewed by Wiedemann (1984, 1993) and Wiedemann et al. (1969). The Recreation Area is underlain by sedimentary bedrock of the Coaledo Formation that originated as offshore marine deposits in the early Eocene, 53 million years ago. These sediments are part of a geosyncline associated with building of the Cascade Range. They are composed of clay, shale and siltstone originating from feldspar and quartz sands, and tuffaceous silts and clays. Toward the end of the Miocene, 7 million years ago, uplifting began to form the Coast Range. Subsequent erosion of the thick sedimentary beds was rapid, resulting in today's low, rounded mountains. The easily eroded rock permitted the development of wave-cut terraces on which present-day sand dunes have developed.

Sea level in the Recreation Area has risen and fallen repeatedly over geologic time, caused by changes in ocean volume associated with cycles of glaciation (Wiedemann 1984, 1993). Repeated subsidence and uplifting of the land mass, resulting from large subduction earthquakes, has also affected sea level (Darienzo and Peterson 1990; Plafker 1990; Komar and Shih 1993; Thilenius 1995). During the late Pliocene and early Pleistocene, about 1 million years ago, a deep submergence created wave-cut terraces as high as 1,400 feet above present sea level. Subsequent uplift lowered the shoreline to 300 feet below present sea level, and it was during this period that rivers and streams cut trenches across the continental shelf. Resubmergence then drowned the river mouths, creating the wide estuaries and salt marshes seen today at the mouths of the Siuslaw and Umpqua Rivers, and in Coos Bay. The last major lowering of the shoreline, to 500 feet below present sea level, occurred during the Wisconsin glacial maximum, about 20,000 years ago. A subsequent resubmergence began about 6000 years ago.

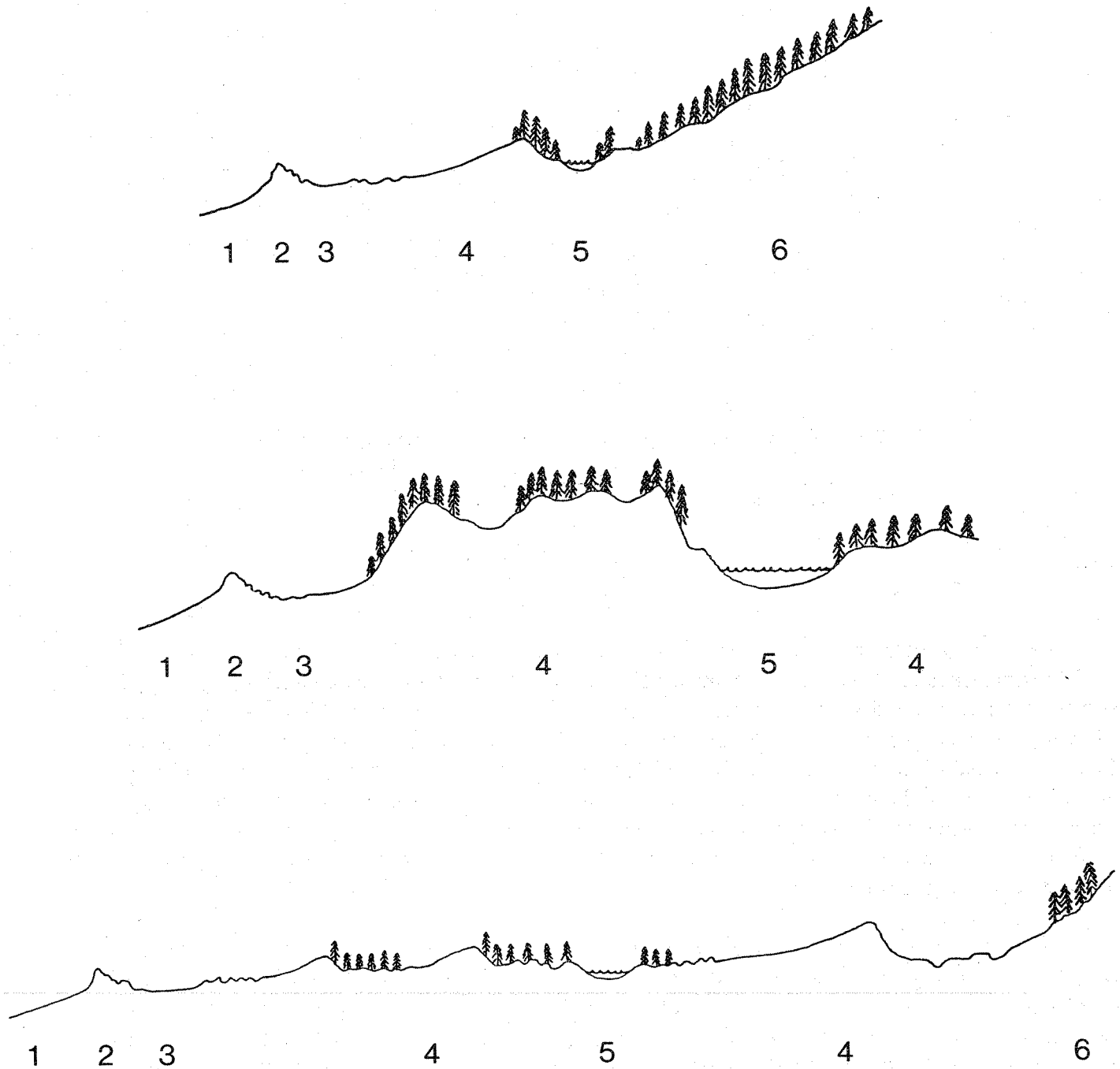


Fig. 3. Three dune profiles, Oregon Dunes National Recreation Area (after Pinto et al. 1972).
 1 – Beach; 2 – Foredune; 3 – Deflation plain; 4 – Transverse dunes and tree islands; 5 –
 Lakes; 6 – Coast Range foothills.

LANDFORMS AND VEGETATION

The sandy landscape of the Recreation Area is a product of past geologic events and the interactions of wind, water, sand supply, vegetation, fire and human activity. Dune formations and processes were reviewed by Cooper (1958), Wiedemann (1984, 1990, 1993), Wiedemann and Pickart (1996) and Wiedemann et al. (1969). The enormous amount of sand dominating the Recreation Area originated from the sediment load transported to the coast by major rivers draining the interior of the region, as well as ongoing erosion along the immediate coastline. Sand is transported along the coast by nearshore and longshore currents. In summer, longshore currents move sand southward, and deposit much of it on beaches. In winter, these same currents, as well as storm-generated wave activity, move sand northward, eroding beach deposits. The annual net movement of sand is northward.

Unconsolidated sand dominates about 70 percent of the Recreation Area. The remaining 30 percent has loam soils of the foothills of the Coast Range, underlain by ancient sandstone. Of the sandy portions, about 20 percent is bare of vegetation. The balance is covered by a broad array of vegetation, ranging from sparse stands of dune grass or herbs, to tall forests of Sitka spruce, Douglas fir and Port Orford cedar, some 300-600 years old, with dense shrub layers of evergreen huckleberry, western hollyhock and wax myrtle up to 15 feet tall. Wind, water, vegetation and topography interact with each other to form several distinctive landforms that occupy different positions in the landscape. These landforms, progressing inland from beaches, include foredunes, deflation plains, and interior dunes some 100 feet tall, the last ranging a mile or two inland (Fig. 3).

Plants on the dunes have adapted to living in nutrient-poor, droughty soils and areas subject to high winds, abrading sand and salt spray. Many exhibit a mat-forming habit, reducing exposure to winds and salt spray, while others develop waxy cuticles, fleshy stems or silvery hairs that resist desiccation and store water in specialized tissues. Most dune plants have extensive root systems that cope with shifting sands, and maximize water uptake (Alpert 1991).

Beaches. Beaches on the Recreation Area typically lack any vegetation except on the landward edge, where beaches grade into foredunes. Surf, wind, sand, and salt are pervasive disturbance factors. Except for an incipient European beachgrass association that forms on hummocks, the occasional herbaceous plants seen on the beach do not form a discernable association. Common species include sea rocket, yellow sandverbena, beach pea, seashore lupine, and sea purslane (Appendix 3 lists common and scientific names). Detritus washed up on beaches usually includes eelgrass, marine algae, dead animals and wood. These materials, mediated by a specialized fauna and flora of decomposers, provide organic material and nutrients to beaches and foredunes. Driftwood, often of large diameter, piles up on beaches, and is often carried into estuaries and deflation plains by large storm surges, where it may remain for decades. The logs provide habitat for plants and animals, sometimes being the only suitable substrate in an otherwise saline or waterlogged environment, and serve as a long-term source of organic material and nutrients. Leuthner (1969) found driftwood logs to host more lichen species than any other substrate in the dunes, and several species recorded were restricted to these logs.

Foredunes. Foredunes are tall ridges created by sand-trapping plants, primarily European beachgrass, tolerant of continual burial by wind-blown sand. Foredunes may reach heights of 25-35 feet, and basal widths of over 320 feet. European beachgrass efficiently traps windblown sand, intercepting most of the sand moving inland from beaches. Nutrients may be elevated in foredunes, because of the input of organic material and salts blown in from beaches.

In the Recreation Area, foredunes did not appear in their present form until after 1935, when the introduced European beachgrass began to spread throughout the region (Wilde 1982; Buell 1992; Wiedemann and Pickart 1996). Prior to this time, the original foredunes had a lower profile, formed by native sand-trapping plants, primarily American dunegrass, yellow sandverbena, seashore bluegrass and beach silver-top. These native species can be effective in building foredunes, as evidenced by the extensive system of old parallel dune ridges north and south of the mouth of the Columbia River. However, foredunes such as these may never have been well-developed along the central coast of Oregon, because of seasonal erosion (Wiedemann and Pickart 1996). Since the advent of European beachgrass, the original foredunes of the Pacific coast have disappeared from most areas and have become a rare landform. Even individual species of original foredune vegetation are now becoming rare. The best remnants of this landform occur at the Lanphere-Christensen Dunes Preserve near Humboldt Bay, in northern California.

Deflation plains. Behind the foredunes are deflation plains, where wind has eroded the sand to the water table, forming a wet surface resistant to further erosion. Many of today's deflation plains are artifacts of the establishment and spread of European beachgrass, and the subsequent creation of large foredunes (Pinto et al. 1972; Wilde 1982). The new foredunes intercepted sand blowing inland from beaches, and sand behind the foredunes subsequently became the source of resupply for interior dunes. Wind has excavated deflation plains that have increased in width continuously over the last 50 years, in some places doubling since 1950 (Pinto et al. 1972). Expansion of deflation plains occurs along their eastern edge, and in some places they are now over half a mile wide. Deflation also occurs further inland in troughs among dunes.

Deflation plains are typically flooded with fresh or brackish water for much of the winter, drying out to a greater or lesser extent in summer. Dried-up depressions are often stained with iron. A variety of moisture and salinity gradients are present throughout the year, dictated by depth of sand and distance from estuaries (Newman 1974, 1983). These gradients have a profound effect on the distribution of plant associations containing the highest diversity of species recorded from the Recreation Area. These include the salt rush and the sickle-leaved rush-salt rush associations. Wetter sites support extensive marshes of slough sedge, Nevada rush and Hooker willow. Drier sandy flats and hummocks support stands of European beachgrass and salt rush. These drier sites are invaded rapidly by dense stands of evergreen huckleberry, salal, shore pine and Sitka spruce. Such stands are often severely pruned by wind-blown sand and salt spray, and usually become impenetrable.

Some deflation plains were present long before the advent of European beachgrass. House described the vegetation of deflation plains in 1914. Goose Pasture, a deflation plain formed around 1813 (Cooper 1958), has changed from a meadow to a Sitka spruce forest in about 60 years. It also exhibits successional stages ranging from mature spruce trees at its western end, to progressively younger stands of pine woods and wetlands at its eastern end. This site represents what many of the deflation plains on the Recreation Area will look like in the future. A similar pattern appears to be developing on deflation plains north of Tenmile Creek.

Interior dunes. Farther inland, a variety of actively moving dunes respond to wind patterns and local topography. They are largely bare of vegetation. Prevailing seasonal winds form two distinctive types of dunes. **Summer transverse dunes** form regular "washboard" patterns east of the deflation plains. They are oriented in a southwest-to-northeast direction, perpendicular to prevailing summer winds. They range from 3-20 feet high, are spaced about 110 feet apart, and are often leveled by winter winds. **Winter transverse dunes** form enormous parallel ridges near the eastern edge of the dune sheet

Described as "oblique dunes" by many authors, Hunter et al. (1983) found that this type of dune rarely became oblique, and the name is best forgotten. These dunes are oriented in a somewhat northwest-to-southeast direction, perpendicular to winter winds. They range from 80-200 feet high, and are spaced 100-1800 feet apart. Some are over a mile long, and move northeasterly about 12 feet per year (Wiedemann 1984). Their eastern faces merge with the **retention ridge**, or precipitation ridge, forming a **slip face** along the eastern edge of the dune sheet. Here, a wall of sand up to 75 feet high can bury existing forest vegetation, and moves inland about 5 feet per year (Wiedemann 1984). Leaning and lying trees, their trunks buried deep in sand, are common along the retention ridge. **Parabola dunes** are formed by vigorous wind erosion that excavates and funnels sand through a trough, forming a U-shaped dune at the distal end, where slip faces similar to retention ridges can bury existing forest. In troughs between dunes, long-buried forests and their ancient soils may be exhumed by the wind.

When vegetation is disturbed to expose bare sand, wind erosion can quickly destroy a stabilized dune. Undermining adjacent vegetation may cause **blowouts**. Remnant mounds of forest, called **tree islands**, are created by such activity. The vegetation on these sites is often deformed by wind into grotesque or aerodynamic shapes. The windward side of tree islands, as well as forest at the edge of the dune sheet, all show familiar "wind pruning" of shrubs and "flagging" of trees. Incipient tree islands can be seen west of Tahkenitch Campground, where peninsular lobes of forest are eroding around their edges, and may someday be cut off from the forest. Tree islands are covered by mixed stands of shore pine, Sitka spruce, Port Orford cedar or Douglas fir, with a dense understory of salal and evergreen huckleberry. Stands typically contain a mix of age classes, including scattered Sitka spruce and Douglas fir up to 650 years old, the oldest trees known from the Recreation Area. The woody parts of trees and shrubs in the interior of these islands are often coated with sand, transported from the surrounding dunes by storm winds, and deposited as a sandy precipitation that becomes cemented to wet stems and branches.

Coast Range foothills. The eastern part of the Recreation Area includes hills rising to 600 feet. A few of these are ancient dunes, but most are underlain by sandstone, and form the western terminus of the Coast Range. These are the "mountain front" of Pinto et al. (1972). Much of the forest is dominated by second-growth Sitka spruce and western hemlock. Forest stands in the foothills are floristically distinct from those on sand dunes, because of the better-quality soil with higher moisture-holding capacity. Perennial streams and red alder occur in valleys between the hills.

Rivers and streams. The Recreation Area is bounded by the Siuslaw River on the north, Coos Bay on the south, and is bisected in the middle by the Umpqua River. Tahkenitch, Threemile and Tenmile Creeks, and Siltcoos River are the only other streams crossing the dune sheet. All are tidal in their lower reaches. A limited number of wetlands are associated with these streams, including those with the best-developed mucky peat soils. In the foothills along the eastern edge of the Recreation Area, permanent streams form the headwaters of lakes and ponds blocked by the dune sheet. Beaver activity is ubiquitous in these streams, where Hooker and Sitka willow are the primary food source. Bottomlands along the streams are the primary sites for red alder on the Recreation Area.

Lakes and ponds. Freshwater ponds and lakes occur throughout the length and breadth of the Recreation Area. Dune-blocked lakes and lakes occurring within the dune sheet were formed by two different processes. Dune-blocked lakes occur along the eastern edge of the dune sheet, and were formed when shifting sands blocked streams draining the Coast Range. Downcut stream valleys were flooded, creating the large lakes east of Highway 101, such as Siltcoos, Woahink, Tahkenitch, and Tenmile Lakes (Cooper 1958). These lakes are usually steep-sided and relatively deep, and water levels may drop as

much as 6-8 feet during the summer. They also have outlet streams large enough to cut across the dune sheet. Many smaller lakes west of Highway 101, such as Cleawox, Carter, Elbow, Threemile and Saunders, were formed in the same manner as the larger lakes. Some of these are connected to each other by streams that flow along the margin of the dune sheet, but all drainage is underground beneath the dune sheet. Most lakes have active beaver populations.

Lakes and ponds occurring within the dune sheet occur in deflated areas where the water table is intercepted. They are typically shallow and subject to seasonal changes in water levels. The best examples occur on ancient deflation plains at the south end of the Recreation Area, between Beale and Horsfall Lakes. These lakes are unique because of their large size and extensive aquatic bed and emergent plant associations, dominated by pond lily, floating-leaved pondweed, water-shield and hardstem bulrush. Several lakes contain water clubrush, an uncommon plant species, and extensive populations of the insectivorous bladderwort. The lakes host large concentrations of waterfowl during the migration season. Cooper (1958) described the drying of these lakes in the 1920's and 1930's. At that time they all contained numerous dead trunks and stumps of shore pine, possible evidence of subsidence and immersion after a subduction earthquake. Groundwater pumping in the wellfield in the Horsfall area may be lowering the water table, threatening the long-term viability of these lakes (Wiedemann 1984).

Salt marsh. Salt marsh is limited on the Recreation Area because little estuarine habitat is present within the administrative boundaries. The best example occurs along the North Slough of Coos Bay, where regular tidal inundation has created broad mud flats laced by tidal streams. Much of the hydrology there has been altered by channelization of North Slough, and construction of the railroad.

Distinctive salt marsh species on the Recreation Area include Lyngby sedge, saltgrass, pickleweed and three-square bulrush. The mouths of both the Siuslaw and Umpqua Rivers are subject to sand burial and dredging, and salt marsh in these areas is very small. Tahkenitch Creek, Tenmile Creek, and Siltcoos River all have small estuaries in which some limited salt marsh development has occurred. These are embayments confined by foredunes, with shifting mouths that are often choked with sand. Such choking limits intrusion of salt water at certain times of the year, causing salinity levels to fluctuate more than in larger estuaries open to regular tidal activity. Storm surges can bring seawater and driftwood far into these marshes. The mouths of Tahkenitch and Tenmile Creeks have shifted north or south over the years in response to currents and the creation of foredunes. Air photos show traces of old floodplain features, such as meandering and ponding, along the lower ends of these creeks, but well above the estuary areas. Large logs on these floodplains also show that they were occasionally overrun by storm surges, presumably before foredunes had built up to their present dimensions. Threemile Creek is too small to support any salt marsh.

SOILS

Soils of the Recreation Area include sands, sandy loams, and silt loams. The shifting and stabilized dunes are composed of excessively-drained and poorly-drained sands. Ancient marine terraces are composed of well-drained and poorly-drained loams and sands. The foothills of the Coast Range, mostly east of Highway 101, are composed of well-drained silt loams. Technical properties of the soils were described by Patching (1987) and Haagen (1989).

Sand dunes. The soils of the sand dunes are extremely poor, lacking both nutrients and organic matter. On most of the sparsely-vegetated dunes, permeability is very rapid. High rainfall leaches most nutrients to levels so low they cannot be effectively measured, and pH is about neutral. Beach and foredune sands may contain elevated levels of nitrate, potassium, calcium, magnesium and sodium, originating from drift deposited on beaches, including seagrass, marine algae, dead animals and wood. These nutrients are scarce on sands farther inland, and are directly proportional to the amount of plant biomass and organic matter on a given site (Clark 1986; Duebendorfer 1992).

Older forests on stabilized dunes and tree islands are underlain by 4-15 inches of gray or grayish brown fine sand or sandy loam, underlain by yellow or brownish sand with very little organic material. Because unstable sandy soils move downslope readily, soil depth varies greatly on the dunes. Under shrubs or in openings on slopes, it may be only 1 inch deep, or altogether absent. Pockets 4-6 inches deep develop at the foot of slopes, or in concavities in midslope. Iron-cemented lenses or nodules may be present below the surface. These soils are highly to moderately permeable, low in nutrients and humus, and have a pH of 5.1-6.0. The Waldport, Netarts and Bullards series, classed respectively as Typic Tropopsamments, Entic Haplorthods and Typic Haplorthods, are the primary soil units. A few remnant dunes surviving from the Pleistocene are distinguished by their reddish-colored soils and iron concretions.

Poorly-drained areas in the dunes develop several different soil profiles, depending on age. Deflation plains develop a brown or dark grayish brown sandy soil 4-7 inches deep, underlain by up to 50 inches of mottled grayish brown sand. Waldport and Heceta series, the latter Typic Psammaquents, are the primary units. Older hydric formations on floodplains and marine terraces develop dark, anoxic reddish brown organic soils 60 or more inches deep, sometimes with iron-cemented hardpan in the underlying gray sand. These soils are moderately permeable. These soils are very acid, with a pH of 4.5-5.0. Brallier mucky peat, a Typic Tropohemist, is the primary unit.

Marine terraces. Marine terraces, occurring at the south end of the Recreation Area, are composed of Pleistocene beach and offshore deposits, with sand, clay, gravel, peat layers and woody remains, underlain by marine sandstone of Pliocene age (Allen and Baldwin 1944; Griggs 1945; Baldwin 1981). Soils are composed of 5-10 inches of dark grayish brown sandy loam, underlain by 20-40 inches of reddish brown sandy loam with a yellowish brown iron-cemented hardpan. Permeability is moderate to very low. Frequent mapping units are Bandon sandy loam and Blacklock fine sandy loam. These soils are Typic Tropaquods, notorious for poor drainage and infertility. They develop 9-12 inches of black or dark gray fine sandy loam, underlain by mottled, brown or yellowish brown, iron-cemented hardpan to depths of 40-75 inches. Blacklock soils are nutrient-poor, poorly drained, and have a pH of 5.0 (Jenny et al. 1969). Vegetation may be conspicuously stunted in areas with seasonal standing water.

Coast Range foothills. The most productive soils on the Recreation Area are deep silt loams that occur mostly east of Highway 101, in the foothills of the Coast Range. The soils formed in colluvium derived from sedimentary bedrock, and have greater moisture-holding capacity than those found on sand dunes. Soils are dark brown or reddish brown silt loam 10-26 inches deep, underlain by silt loam and silty clay loam 14-26 inches thick, sometimes with fractured siltstone. Salander and Templeton are the primary series, classified as Typic Dystrandepts and Andic Humitropepts, respectively.

HYDROLOGY

Although dune sands have poor moisture-holding capacity, they are underlain by large groundwater reserves that maintain a high water table throughout much of the Recreation Area. The aquifers range from 115-230 feet thick, bound on the east by the basal bedrock of the Coast Range, and extending westward under the ocean (Brown and Newcomb 1963; Wiedemann 1984). The groundwater drains into lakes, streams, North Slough and the ocean. Winter precipitation elevates the water table and inundates some deflation plains to a depth of 3 feet. The seasonal rise in water table also causes vernal pools to form in forested sites on old deflation plains, most notably in the shore pine\slough sedge association. These pools are teeming with invertebrates and are temporary sources of food and breeding grounds for amphibians and migrating waterfowl.

Although the water of the dune aquifers is of good quality, with a somewhat acidic pH of 5.7-6.2, iron makes it less potable in some areas (Brown and Newcomb 1963; Wiedemann 1984). The cities of Florence, North Bend and Coos Bay obtain most of their water supplies from dune aquifers, collected by well fields scattered over the dune sheet. Groundwater pumping on the North Spit of Coos Bay has raised concerns about year-round depression of the water table, dewatering valuable wildlife habitat and possibly altering plant succession at these sites (Wiedemann 1984). The issue is currently under investigation.

Because sands are so permeable, surface runoff occurs only on the silt loams of the Coast Range foothills along the eastern edge of the Recreation Area, and no streams originate in the dune sheet. On stabilized dunes with mature forest cover, steep-walled gullies give the illusion of stream channels, but are merely points where two old dune slip faces join together. Water rarely accumulates at these sites, unless they intersect the elevated winter water table.

Brackish water occurs in the estuaries of Coos Bay, and at the outlets of the few streams crossing the dune sheet. It also occurs to a limited extent in deflation plains adjacent to estuaries. Lakes occurring at the eastern edge of the dune sheet have subterranean outflows beneath the dunes, and probably feed directly to the water table. Cleawox Lake drains in this manner, and irrigates Goose Pasture on the deflation plain about a mile west of the lake (Cooper 1958; Wiedemann 1984).

DISTURBANCE PROCESSES

The major agents of disturbance on the Recreation Area have been shoreline displacement, wind, salt, fire, and human activities. These forces have mediated the supply, movement, chemistry, and exposure of sand, and have, in turn, influenced development of vegetation on the dunes. The instability of sand, however, is the major factor controlling plant succession on the Recreation Area.

Shoreline displacement. Cyclical changes in sea level, associated with glaciation and tectonic events, were credited by Cooper (1958), Wiedemann (1984, 1993) and Wiedemann and Pickart (1996) to have triggered cyclical dune activity. Subsidence or uplift of 6-9 feet associated with earthquakes would destroy existing dune formations and vegetation, and initiate new successional pathways, particularly in wetlands (Plafker 1990; Thilenius 1995). Estimated birth dates for certain dune types coincide with radiocarbon and thermoluminescence dates obtained on the Recreation Area and elsewhere, and support the general notion that major earthquakes occur at 300-1000 year intervals. The most recent events seem to have occurred about 300, 1,050, 1,650 and 2,400 years ago.

Wind. Wind drives the seasonal movement of large dunes, causing burial of forest vegetation along the eastern edge of the dune sheet, and exhumation of previously-buried forest in interdunal troughs. Storm winds fell many trees in exposed areas, and windfall is conspicuous in stands containing senescing shore pine. Wind-driven sand and salt abrade and stunt vegetation, and can kill buds and leaves of both conifers and shrubs. In exposed areas, removal of vegetation can leave the underlying sand vulnerable to wind erosion, leading to formation of blowouts or complete destruction of stabilized dunes. McLaughlin and Brown (1942) described the extensive erosion of stabilized dunes on the Clatsop Plains caused by livestock trails cutting through the turf to expose sand to the wind.

Fire. Fire probably played a secondary role as an agent of disturbance in the Recreation Area. Most ignition sources were likely aboriginal, as lightning is uncommon along the immediate coast. Shifting dune sands frequently expose buried soils, and these often contain charcoal. Charcoal is visible in shore pine forest south of Threemile Lake, and in 300-400 year-old stands of Port Orford cedar near Hauser and in the Horsfall area. The only fire scars on standing trees were seen on Port Orford cedar at Horsfall.

Most forest fires in the Coast Range are thought to have been intense and infrequent, occurring in a 150-350 year fire return interval (Teensma et al. 1991). Fire frequency increased dramatically in the Coast Range after 1845, when white settlers began clearing land (Morris 1934), but it is largely unknown whether these fires extended onto the Recreation Area. Morris (1934) and Teensma et al. (1991) recorded large fires in the vicinity of the Recreation Area in 1846, 1849 and 1868. Around Florence, abundant charcoal and even-aged stands of shore pine date from stand-replacing fires between 1835-1865 (Cooper 1958).

The fragmented nature of forest and tree islands, with sand surfaces in between, may be a result of past burns, but is more likely due to wind erosion. The complex pattern of vegetation and sand would have caused discontinuous burning, creating variable patch sizes and age classes. Some tree islands appear to have escaped fire for up to 650 years. Although many stands of shore pine originated during primary succession on shifting sand, or were planted, others date from stand-replacement fires, and even-aged stands are typical on the dunes. The high incidence of rare lichen species along the immediate coast, in contrast to their relative dearth farther inland, may in part be due to the low incidence of fire.

Insects and pathogens. Forest insects reported to occur on the Recreation Area include the pitch nodule moth, engraver beetles and root weevils. Pathogens known or thought to occur in the area include gall rust, canker and needle cast on shore pine, and needle rust on Sitka spruce (Pinto et al. 1972). Port Orford cedar root disease has recently been identified from the Recreation Area. Except for Port Orford cedar root disease, none of these fungi appear to be limiting stand growth in any significant way. Control measures for Port Orford cedar root disease should exclude motorized recreation from the vicinity of known stands. Pine plantations near Lagoon Campground, cited by Pinto et al. (1972) as a center of infestation by root weevils, appear to be healthy.

Agriculture and grazing. Although people have lived on the central coast of Oregon for at least 10,000 years, the area was sparsely settled by Native Americans and Europeans until the 1870's, when grazing and farming became more prevalent. The effects of livestock grazing and cultivation, as well as construction of buildings, jetties, roads, railroads and trails, have all been responsible for rejuvenation of sand movement (McLaughlin and Brown 1942). Early in the century, cattle crossed the dunes from Siltcoos and Woahink Lakes to graze Goose Pasture until it was "cropped short" (Siuslaw National Forest 1912-1916). Munger (1967) recalled that too many cattle grazing on the North Spit around 1910

caused sand to drift into the bay and block the mouth of the Umpqua River. Cooper (1958) noted that cattle had grazed the Recreation Area since at least the 1890's, and were responsible for rejuvenation of sand movement between Tenmile Creek and Coos Bay. Aerial photography shows that homesteads were present at the mouth of Tenmile Creek, the south end of Threemile Lake, and on the Coos Bay spit as late as 1936. These activities no doubt influenced plant succession in certain areas of the Recreation Area. Cultivation and grazing break up vegetation and expose the sand to wind erosion. Weed species that disrupt natural plant succession are also introduced. Cultivation of cranberries began at Hauser as early as 1885, and a number of smaller lakes near the south end of the Recreation Area contain remains of abandoned berms and wooden dams, evidence of this industry. These activities disrupted hydrology and aquatic vegetation, and the plant associations of these areas may still be recovering from the effects.

Logging. Forests on the uplands of the Recreation Area were cut over between 1915 and the 1960's, mostly east of Highway 101. Some stands have been cut two or three times. Near Siltcoos Lake, western red cedar was selectively logged prior to 1940, leaving 200 year-old Sitka spruce stands with altered composition. Most such stands were never thinned, resulting in a dense canopy with sparse shrub and herb layers. Red alder dominates some sites formerly occupied by conifer forest. Old-growth forest is rare on the Recreation Area. Scattered individuals of Sitka spruce and Douglas fir up to 650 years old occur in tree islands. Stands of old-growth Port Orford cedar occur near Hauser and in the Horsfall area at the southern end of the Recreation Area. Old-growth Douglas fir and western hemlock occurs on stabilized dunes between Loon Lake and Carter Lake, although part of this stand was clearcut in the 1960's. Old-growth shore pine, 120-150 years old, occurs on tree islands and in the Horsfall area.

Changes in hydrology. The well field in the Horsfall area, at the south end of the Recreation Area, is being studied to monitor changes in groundwater levels, and its potential effects on wetlands. Sustained pumping of groundwater may alter extent and composition of seasonal or perennially-flooded wetlands. If dewatering is sustained over a period of years, shallow lakes may be replaced by dry or seasonally-wet associations typical of deflation plains. Because sand is highly permeable, excessive pumping may also cause pollution of groundwater by infiltration of salt water, sewage, fertilizers and pulp mill wastes.

Recreation. Recreational off-road vehicles, horseback riding, and hiking can damage vegetation and wetlands if traffic is concentrated, or occurring in fragile areas. Compaction or displacement of sand can destroy fragile native dune vegetation as well as exotic European beachgrass, and rejuvenate sand movement in stabilized areas. Weed seeds and fungal spores adhering to machines, horses and clothing can be dispersed into previously pristine areas. Particularly vulnerable are the red fescue, seashore bluegrass, shore pine/bearberry, and shore pine/hairy manzanita associations. These associations have delicate root systems or thin, fragile layers of lichens, mosses and bearberry covering the sand.

Off-road vehicles have damaged some plant associations throughout the Recreation Area, and damage to wetlands is evident around Horsfall Lake. Similar activity in the Sand Lake dunes, 80 miles north of the Recreation Area, has destroyed nearly all of the red fescue and shore pine/bearberry associations in the last 30 years since such vehicles became popular (Wiedemann 1984, 1990, 1993).

Brown (1990) documented hiking damage to two dune associations in northern California, including a "dune mat" containing elements of the red fescue, seashore bluegrass, and shore pine/bearberry associations. Under the heaviest of four experimental trampling regimes, he observed a 50 percent decline in cover in both types of vegetation. The shore pine/bearberry association was initially more resilient than the dune mat association, but took longer to recover, and reindeer lichens (*Cladina* and *Cladonia* spp.) disappeared from the plots. Neither vegetation type showed appreciable

recovery after 1 year. Research in Scotland (Bayfield 1979; Bayfield et al. 1981) indicates that the lichen layer could take more than 8 years to recover from trampling.

PLANT SUCCESSION

If disturbance processes were absent from the Recreation Area, a classical sequential successional pathway would begin with aquatic vegetation and culminate in mature forest. Classical successional patterns are sometimes evident in both uplands and wetlands of the Recreation Area, as one association grades into another, with vestiges of preceding types providing clues about antecedent vegetation. However, in most of the area underlain by sand and exposed to wind, instability is the rule. Here, the classical linear pattern of succession is seldom followed, and late seral or climax associations are rare. A cyclical process is common to much of the area, where dune surfaces become stabilized by a series of plant associations, eventually becoming forested, only to return to open sand again because of burial by shifting dunes, or rejuvenation of wind erosion caused by removal of protective vegetation. Rejuvenation of sand movement in previously stabilized areas, or *de novo* infiltration or burial by sand, can trigger invasion by European beachgrass in nearly any association in nearly any locality in the Recreation Area. The putative successional sequence may then start over with European beachgrass, instead of whatever had been growing there previous to the advent of new sand. Complex patterns of vegetation are typical, with vastly different vegetation types occurring side by side.

The idealized successional pathways outlined here for both uplands and wetlands follow a hypothetical linear progression, assuming no intermediate disturbance. We recognize early, mid and late seral stages, as well as climax, as defined by Hall et al. (1995).

Because succession in wetlands is complicated by seasonal and long-term variation in moisture, salinity gradients, and microtopography, successional pathways are not as obvious as in uplands. Changes in sedimentation, elevation, dominance of certain species, and presence of species remaining from previous associations are clues indicating possible successional pathways. Most wetland associations are early seral, and two different pathways are evident on the Recreation Area. The first pathway occurs along streams and lakes, where associations change from aquatic bed to emergent marsh, to shrub swamp, to climax Sitka spruce swamp. The second pathway occurs on deflation plains where brackish associations grade into freshwater associations, culminating in transition to upland associations.

Plant associations of perennially flowing or perennially ponded water (Fig. 4) are flooded or saturated year-round, and organic soils are typical. Floating aquatic plants growing on or below the surface of the water (pond lily and floating-leaved pondweed associations) are replaced by associations of erect, emergent plants (inflated sedge, hardstem bulrush and simplestem bur-reed associations) when water depths become shallower with infilling by sediment and detritus. The slough sedge association develops on saturated, organic soils along streams and lakes, and is later invaded by long-lived stands of Douglas spiraea and Hooker willow that respond to disturbance by vigorous resprouting. These stands are eventually replaced by the climax Sitka spruce-red alder/slough sedge-skunk cabbage association, which may live 300 years or more. Stands of this type are rare on the Recreation Area, and never extensive in area.

Plant associations in brackish water (Fig. 5) are flooded in winter, but dry out in summer, and never develop much organic matter. Succession progresses from low salt marsh (saltgrass-Pacific silverweed and three-square bulrush associations) to high salt marsh (Lyngby sedge-Pacific silverweed,

Baltic rush-Pacific silverweed, and creeping bentgrass associations), typical of estuaries along the northern Pacific coast. Depending upon the availability of fresh water, high salt marsh associations appear to be replaced by either freshwater or upland associations. Succession in freshwater is mediated by water depth and seasonal availability.

Freshwater wetland associations derived from brackish water associations (Fig. 6) are arrayed along an elevational gradient, mediated by influx of sand. These usually occur on deflation plains. Younger stands are dominated by the creeping spikerush-Nevada rush association, and the slough sedge-Pacific silverweed association, which are seasonally flooded but dry out by midsummer, with the water table at or below the ground surface. Slightly higher surfaces are invaded by shrubs, to form the Hooker willow/slough sedge-Pacific silverweed association, and two associations dominated by bog blueberry. The Hooker willow sites are wetter than the bog blueberry sites, and are soon colonized by shore pine, which after 20 to 50 years excludes the willow to form the distinctive, seasonally-flooded shore pine/slough sedge association that may persist for more than 100 years. Continued infilling by sand and other woody species replaces these associations with those typical of upland dunes.

Upland dunes slowly become stabilized by a series of associations dominated by herbs or graminoids (Fig. 7). Pioneers include European beachgrass, American dunegrass, salt rush, seashore lupine, and seashore bluegrass. Diminishing movement of sand allows colonization by red fescue. At this point, shrubs and small trees begin to invade stabilized areas, establishing associations dominated by woody species (Fig. 8). Early stages include the tree lupine/European beachgrass, shore pine/bearberry, shore pine/hairy manzanita, and shore pine/Scot's broom/European beachgrass associations. Mosses, lichens and bearberry form extensive, conspicuous layers covering the bare sand. These stands become well established between 30-60 years, and persist for up to 130 years.

Once the shore pine associations are well established, Sitka spruce, Douglas fir, western hemlock and Port Orford cedar begin to invade, forming associations dominated by these species. The more or less open shrub layer of hairy manzanita is replaced by dense, sometimes impenetrable stands of evergreen huckleberry and western rhododendron. Organic material accumulates to form a dark layer of humic soil over the bare sand.

Older forest stands accumulate thicker layers of humic soil than younger forests, with the thickest deposits occurring at the base of slip faces of old dunes. Shore pine in these stands senesces between 80-130 years, and is not replaced unless gaps in the canopy are created by windfall, disease or fire. Douglas fir and western hemlock cannot tolerate salt spray, and occur only in sheltered stands or remote from beaches. In contrast, Sitka spruce and shore pine are more tolerant of salt, and are frequent invaders of deflation plains where salt-laden winds are common year-round. Species that apparently favor salt spray, because they occur only along the immediate coast, include silk tassel and Scouler's polypody. Very old forests are rare on the Recreation Area, but include associations dominated by Douglas fir, Sitka spruce, western hemlock, and Port Orford cedar between 200 and 500 years old. At any point along this idealized successional pathway from bare sand to climax forest, something may intervene to disrupt the pattern.

EXOTIC PLANTS

Many non-native species of plants are present in the Recreation Area. While most have invaded naturally, or were introduced unintentionally by people, livestock or machinery, others were planted

widely for dune stabilization and wildlife habitat. McLaughlin and Brown (1942), Green (1965), Munger (1967), Pinto et al. (1972), Meyer and Chester (1977) and unpublished documents on file at the Oregon Dunes National Recreation Area headquarters chronicle planting activity on the Recreation Area since 1908. Exotic species persisting from plantations include European beachgrass, black pine, Scot's broom, tree lupine and bird-foot trefoil. Native shore pine, red fescue and American dunegrass were also planted in a number of places for stabilization or enhancement of wildlife habitat.

Widespread planting of exotic, nitrogen-fixing species, especially Scot's broom, tree lupine and birds-foot trefoil, has had profound effects on nitrogen-poor dune soils. Pickart et al. (1990) found that bush lupine elevated levels of ammonium in the sand, and increased soil moisture through shading. These changes fostered invasion of exotic annual grasses and other weeds that, in turn, increased levels of organic matter and nitrate in the soil. Scot's broom produces a similar effect on soils. While these are precisely the objectives of dune stabilization programs, the effects disrupt native plant associations.

Five types of sites on the Recreation Area, each driven by disturbance processes, appear to be especially vulnerable to invasion by exotic species:

Sites with active sand deposition. Sites with active deposition of sand are favored habitat for European beachgrass. This species is most abundant on foredunes, portions of deflation plains, and lee slopes of moving dunes. European beachgrass is responsible for the buildup of large foredunes and creation of broad deflation plains, which have cut off the supply of beach sand to dunes further inland. Its competitive superiority and sand-trapping ability have enabled it to infiltrate and destroy nearly all stands of native vegetation on open, partially-stabilized dunes (Wiedemann 1984, 1990, 1993; Boyd 1992; Wiedemann and Pickart 1996). It invades and replaces American dunegrass and seashore bluegrass associations, and to a lesser extent the red fescue association, making these the rarest native plant associations in the Recreation Area. Several native plant species present in these associations, including pink and yellow sandverbena, large-headed sedge, American dunegrass and beach silver-top are also becoming rare because of invasion by European beachgrass.

European beachgrass, first planted on the Recreation Area to stabilize shifting sand on the North Spit around 1910, began to spread naturally by 1930, and after 1935 it was planted widely (McLaughlin 1939; Arnst 1942; McLaughlin and Brown 1942; Munger 1967; Meyer and Chester 1977). By 1970, it had spread the entire length and breadth of the dune sheet. In northern California dunes, 50 years of aerial photography showed that the grass had increased its cover 574 percent, spreading at an average rate of 2.5 acres per year between 1939 and 1962, and 12 acres per year between 1962 and 1989 (Buell 1992).

Early stages of stabilization by shrubs. Sand dunes with relatively little movement of sand begin to develop stands of shrubs and small trees. This is favored habitat for Scots' broom, and to a lesser extent, tree lupine. Scot's broom ranges from just behind foredunes to interior dunes, while tree lupine is largely restricted to areas just behind foredunes. On the Recreation Area, tree lupine grows where European beachgrass has already displaced native vegetation. While Scot's broom can flourish in established stands of European beachgrass, it also invades native associations, particularly the shore pine/bearberry and shore pine/hairy manzanita associations. Invasion by Scots' broom replaces the shrub layer, and initiates changes that affect soil chemistry and subsequent plant succession. Shading and increased soil nitrate under these shrubs allows invasive annual grasses and other weeds to thrive (Pickart et al. 1990).

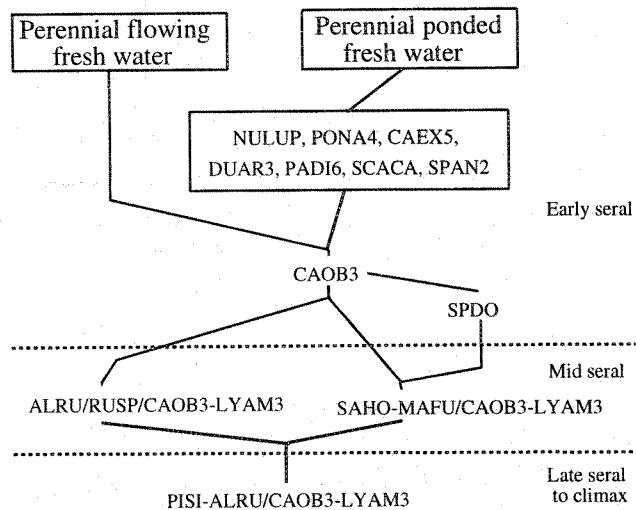


Fig. 4. Idealized successional pathways for freshwater wetland plant associations derived from perennial flowing or ponded fresh water, in absence of disturbance, Oregon Dunes National Recreation Area. Time since disturbance increases from top to bottom of figure. Species codes are defined in Appendix 3.

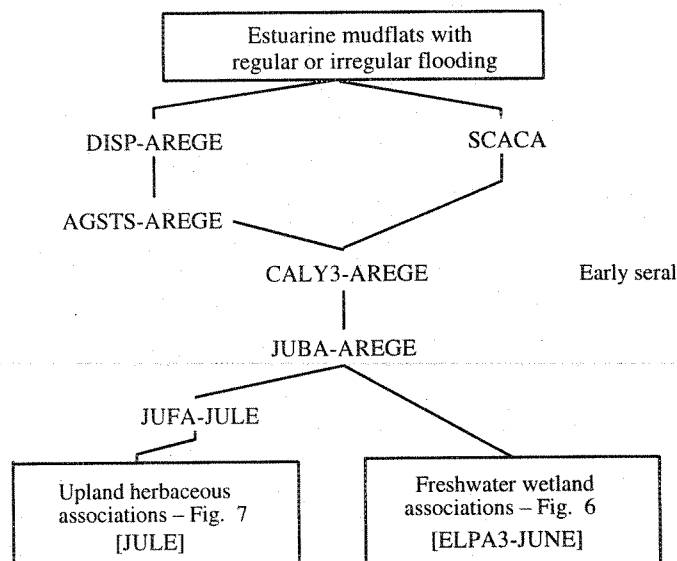


Fig. 5. Idealized successional pathways for brackish wetland plant associations, in absence of disturbance, Oregon Dunes National Recreation Area. Time since disturbance increases from top to bottom of figure, while salinity decreases from top to bottom. Species codes are defined in Appendix 3.

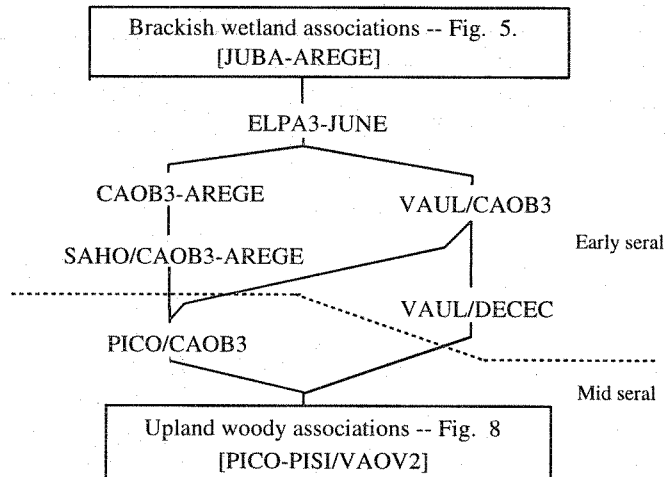


Fig. 6. Idealized successional pathways for freshwater wetland plant associations on sandy soils, in absence of disturbance, Oregon Dunes National Recreation Area. Time since disturbance increases from top to bottom of figure. Species codes are defined in Appendix 3.

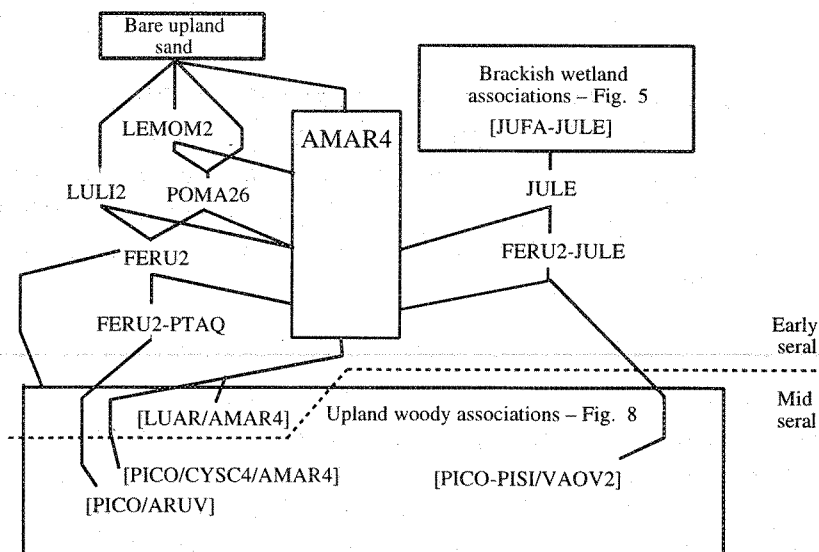


Fig. 7. Idealized successional pathways for upland herbaceous associations, in absence of disturbance, Oregon Dunes National Recreation Area. Time since disturbance increases from top to bottom of figure. Species codes are defined in Appendix 3.

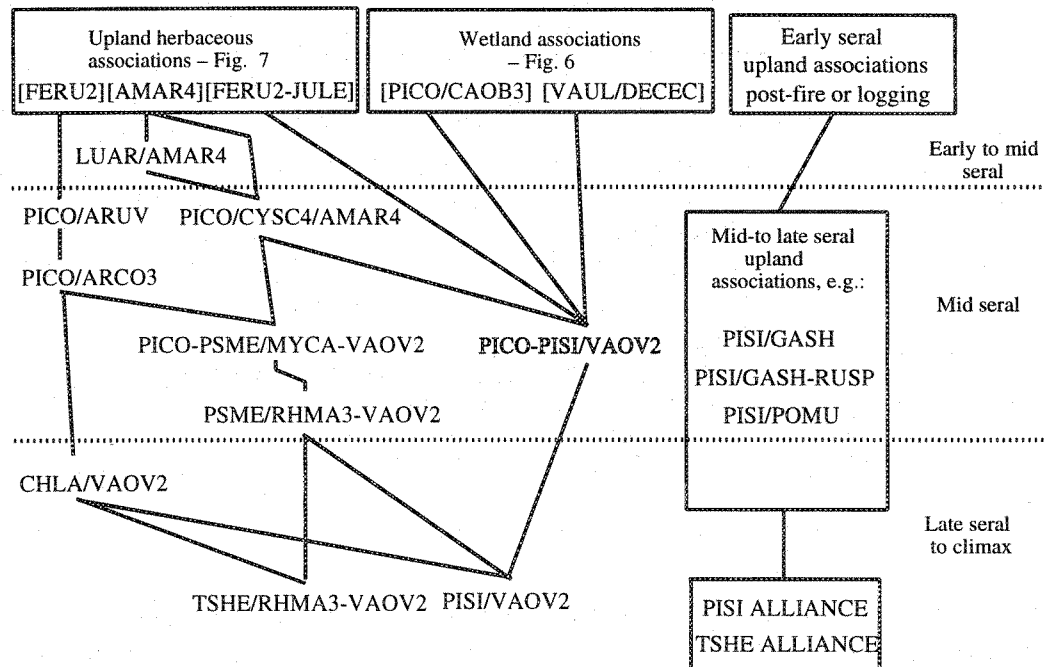


Fig. 8. Idealized successional pathways for upland woody plant associations, in absence of disturbance, Oregon Dunes National Recreation Area. Time since disturbance increases from top to bottom of figure. Species codes are defined in Appendix 3.

Scot's broom was planted in the Recreation Area as early as 1910 as a source of nitrogen for plantations of European beachgrass and shore pine (McLaughlin and Brown 1942; Munger 1967; Pinto et al. 1972). Two or three species of broom were planted along the Pacific Coast, and have spread aggressively by self-seeding (McClintock 1979, 1985). They invade many habitats and alter both soils and plant succession (Mountjoy 1979). Control efforts, while successful locally, have had little effect on the continued spread of Scot's broom (Bravo 1985).

Tree lupine, also called yellow bush lupine, is less common on the Recreation Area than European beachgrass. Most populations are now limited to the South Jetty of the Siuslaw River, where many have died in recent years. In northern California, 50 years of aerial photographs showed that it had spread at an average rate of 6.4 acres per year (Miller 1987). Tree lupine originally was native as far north as Marin County (Davy 1902; Miller 1988) or Mendocino County (Sawyer and Keeler-Wolf 1995). More northerly populations, including those on the Recreation Area, originated from plantings for dune stabilization, ornamental purposes, and subsequent self-seeding (Miller 1988).

Sites with intermittent flooding. Recently drained sites with exposures of bare sand are favored habitat for false dandelion, birds-foot trefoil, velvet grass, sweet vernal grass, silver hairgrass, and Australian fireweed. These sites include seasonally-flooded deflation plains and recently-drained beaver ponds. Plant associations most affected are the salt rush, sickle-leaved rush-salt rush, and aquatic bed associations. The seasonally-flooded habitats exhibit high densities of weedy species, but the

associations are not replaced completely by invading species. These associations have the highest species diversity of any sampled on the Recreation Area. The aquatic bed associations are replaced by Australian fireweed, followed by native species such as slough sedge or Douglas spiraea, until new beaver dams flood the sites.

Open water and marshes. Open water and marshes are favored habitat for parrotfeather, Brazilian waterweed, and yellow iris. Aquatic bed associations and those in freshwater emergent marshes are most at risk of invasion. Native species may be replaced by monocultures of alien species, with little food or habitat value for vertebrates and invertebrates. The lagoon on the Siltcoos River has an especially large infestation of parrotfeather.

Forests of Coast Range foothills. Forest stands east of Highway 101 are being invaded by English ivy and holly. Both of these species are shade tolerant and produce prolific crops of bird-dispersed seed. They alter the structure of the understory and can outcompete native species in the herb layer.

FLORA

Fungi. Fungi have never been inventoried systematically in the Recreation Area, but hundreds of species are no doubt present. Mycorrhizal fungi are present in all plant associations, and are critical for survival under poor soil conditions, such as those present in sand. In northern California, all vascular plants of the "dune mat" of Pickart et al. (1990) hosted mycorrhizae. Their "dune mat" contains elements of the red fescue and seashore bluegrass associations described in this guide. Fungal spore density and colonization reportedly were directly correlated to stability of the site. Edible mushrooms, particularly chanterelles and matsutake, are plentiful and much sought after in shore pine associations, including plantations, on the Recreation Area. Studies are underway to examine the effect of different habitats on matsutake productivity, and to monitor response to different harvest regimes (Pilz et al. 1996; Hosford et al. 1997).

Lichens. The lichen flora of the Recreation Area is rich, and includes many species known to occur in the Pacific Northwest only along the immediate coastline. Leuthner (1969) reported 33 species from dune habitats in the Florence area, including two sites in the Recreation Area at Cleawox Lake and Carter Lake. Recent collecting indicates there could be as many as 100 species present. Neitlich and McCune (1995) reported 74 taxa from the Bureau of Land Management's 216-acre Heceta Dunes Area of Critical Environmental Concern, just north of the Siuslaw River.

Drift logs, shore pine and Sitka spruce forest, and the shore pine/bearberry and shore pine/hairy manzanita woodland associations are particularly rich in lichens (Leuthner 1969, McCune et al. 1997). The ground in the shore pine/bearberry and shore pine/hairy manzanita woodland associations is often covered by conspicuous stands of the reindeer lichens *Cladina portentosa* ssp. *pacifica*, *Cladonia cervicornis*, *Cladonia furcata*, and at least six other taxa of *Cladonia*. These stands are rich in pollution-intolerant, nitrogen-fixing species of *Lobaria*, *Nephroma*, *Pannaria*, *Peltigera*, *Pseudocyphellaria*, and *Sticta*. These taxa are best developed in older forests (Forest Ecosystem Management Assessment Team 1993), but because old forests are rare in the dune sheet, the lichens occur instead on shrubs in these relatively long-lived seral plant associations, and also in mature stands of the Hooker willow-crabapple/slough sedge-skunk cabbage association (McCune et al. 1997).

Shore pines support showy populations of *Coccotrema*, *Ochrolechia*, *Parmotrema*, and *Pertusaria*, characteristic of coastal forest and woodland, but rare or absent inland. Epiphytic *Alectoria*, *Bryoria*, *Hypogymnia*, *Platismatia*, and *Usnea* are ubiquitous. Rare lichens occurring in or adjacent to the Recreation Area include *Anaptychia setifera*, *Buellia oidalea*, *Erioderma sorediatum*, *Hypogymnia subphysodes*, *Pannaria rubiginosa*, *Pseudocyphellaria mougeotiana*, *Leioderma sorediatum*, and *Usnea hesperina* (Neitlich and McCune 1995; McCune and Rosentreter 1997; McCune et al. 1997). These species of *Erioderma*, *Hypogymnia* and *Leioderma* are otherwise known only from the Southern Hemisphere. Most of the common epiphytic species on trees persist into later seral stands, but the uncommon species disappear as light levels diminish. The reindeer lichens characteristic of woodland associations persist in openings of later seral stands, as long as enough light is available to support hairy manzanita, but eventually disappear entirely with canopy closure. The presence of rare lichens along the immediate coast may in part be due to the historically low incidence of fire in dune habitats.

Bryophytes. Bryophytes have never been systematically surveyed on the Recreation Area, but probably about 75 species occur there (J.A. Christy, unpublished data). Mosses, particularly *Ceratodon purpureus*, *Dicranum scoparium*, *Pleurozium schreberi*, *Polytrichum juniperinum*, *Polytrichum piliferum*, and *Racomitrium canescens*, are most conspicuous in shore pine woodland associations, where light levels are high and nutrient levels are low. Mosses are always present in more mature forest stands, with epiphytic species sometimes occurring in great abundance in the dense shrub layer. Species diversity in these stands is low, and varies little from one plant association to the next. Liverworts are not common in the Recreation Area, in part because of the lack of large-diameter decaying logs and lack of streams and other moist, shady sites.

Almost all the bryomass in forests on the Recreation Area is composed of the mosses *Eurhynchium oreganum*, *Isotheceum myosuroides*, *Plagiothecium undulatum*, and *Rhytidiadelphus loreus*. Well-developed mats of *Antitrichia curtispendula*, best represented in late-seral forests (Christy and Wagner 1996), were seen only in the old-growth western hemlock/western rhododendron-evergreen huckleberry forest near Loon Lake. The rare *Campylopus schmidii*, occurring on deflation plains of the South Jetty, and in the shore pine/slough sedge association north of Florence in the Heceta Dunes and Sutton Creek area, has a trans-Pacific distribution extending to Hawaii and Malaysia. It has been known from the Florence area since the 1930's, but has failed to expand its range since then. In contrast, *Campylopus introflexus*, native to the southern hemisphere, is a weedy immigrant that has rapidly invaded stabilized sandy areas throughout the Recreation Area.

Vascular plants. Some 260 species of vascular plants have been reported from the Recreation Area (Appendix 3). The diversity of landforms, soils, and presence of both brackish and fresh water, account for the great number of species. Dry and seasonally wet deflation plains have the highest species diversity (Table 5). Knobcone pine, black pine, Monterey pine, Scots pine, and coast redwood were planted for dune stabilization and also as ornamentals, but are not known to be reproducing. Scots broom, tree lupine, birdfoot trefoil and European beachgrass were planted for stabilization programs, and all have naturalized. Many other species are widespread, invasive Eurasian weeds. Rare species include whorled marsh pennywort, pink sandverbena, salt-marsh birds's-beak, bog clubmoss, and adder's tongue. Pink sandverbena occurs in dry dune habitat threatened by European beachgrass and off-road vehicles, and the other species occur in estuarine or freshwater wetlands.

Plant associations. This guide describes and classifies 52 plant associations found in the Recreation Area, and there are no doubt others that escaped our attention. The extent of a number these associations has declined throughout the region, because of exclusion by invasive species, dune stabilization, and

possibly the absence of fire. Rare associations of open dunes include the American dunegrass, red fescue, and seashore bluegrass associations, declining because of invasion by European beachgrass. The shore pine/bearberry and shore pine/hairy manzanita associations are becoming rare because of damage by off-road vehicles, and changes in succession resulting from dune stabilization and possibly cessation of fire. The bog blueberry/tufted hairgrass association and the shore pine/slough sedge association are rare because they were never common or of large extent, although the latter may be increasing because of the expansion of deflation plains. The Sitka spruce-red alder/slough sedge-skunk cabbage association is rare because it may never have been common, and almost all known occurrences have been logged. The Port Orford cedar/evergreen huckleberry association is rare because most stands have been logged, and the few remaining examples on or adjacent to the Recreation Area are being infected by the lethal Port Orford cedar root disease.

FAUNA

A number of references reviewed by Wiedemann (1984) and Pickart (1990) describe the fauna of the coastal area, but make no specific mention of the Recreation Area. The complex topography, vegetation, and presence of both fresh and salt water in the Recreation Area creates a great variety of wildlife habitat. Wiedemann (1984) identified seven structural types in a classification of wildlife habitat: open dunes, grassland and meadow, shrub thicket, forest, marsh, riparian, and lakes and ponds. To this list could be added the habitat of streams and rivers cutting across the dunes, and salt marsh, with its fauna so different from freshwater systems. Pickart (1990) reviewed work documenting the relative paucity of vertebrates in open dune habitats, and the rich fauna of willow swamps and conifer forest, in dunes of northern California. Shore pine forest had fewer species, thought to reflect the large amount of edge habitat unsuitable for forest birds. Amphibians were limited to the coniferous forest, where greater moisture and organic content provided more habitat. Because of the lack of cover in the open dunes, tracks in the sand suggest that most use of this area by both vertebrates and invertebrates is nocturnal.

Pinto et al. (1972) listed 426 species of birds, fish, shellfish, mammals, reptiles and amphibians known or expected to occur in the Recreation Area. A more recent source estimates the total number of wildlife species to be about 470, including 316 birds, 54 mammals, 12 amphibians, 3 reptiles, 54 estuarine fish, 20 freshwater fish, 9 anadromous fish, and 2 shellfish (Siuslaw National Forest 1994). Larger mammals include black bear, elk, bobcat, coyote, black-tailed deer, beaver, skunks and raccoons. Bird life is abundant, including great blue heron, egrets, osprey and a variety of songbirds. Rare species include the bald eagle and western snowy plover. Eagle nests have been recorded from Tenmile Creek, near Siltcoos Lake and near Gardner, while the plover nests have been recorded near Siltcoos River, the North Spit, south of Tahkenitch Creek, and in the Tenmile Creek estuary. Tenmile Creek, Threemile Creek, and the Siltcoos and Siuslaw rivers are thought to support runs of coho salmon. The larger lakes contain trout and bass, the latter an introduced species. Estuarine mud flats contain a variety of marine invertebrates, including shellfish. Wiedemann (1984) and Pickart (1990) reviewed what little is known of the invertebrate fauna of the dunes, many of whose tracks and burrows can be seen on the sand.

SITE PRODUCTIVITY

Drought, low nutrient status, and low pH render most soils on the Recreation Area unproductive for tree growth. Despite moderate temperatures and low rates of evaporation, moisture stress in droughty

sand may limit plant growth in late summer. During summer, fog drip may be the only source of moisture for weeks at a time. Burial by shifting sand also stunts or terminates tree growth and may initiate attack by insects (Pinto et al. 1972) or fungi. Templeton silt loam is the most productive soil for commercial conifer production, while most other soils of the Recreation Area have low productivity (Table 2).

Management constraints on dry, highly permeable dune soils include slumping, windthrow, drought, and rejuvenation of sand movement by wind erosion. Constraints for upland silt loams include compaction, sheet and gully erosion, and unstable slopes (Patching 1987; Haagan 1989).

METHODS

Data collection. Plant associations were identified by collecting data in sample plots, and analyzing the data to group together similar vegetation types. Vegetation data were collected from plots sampled along permanent transects, as well as larger reconnaissance plots scattered throughout the Recreation Area. Plots were sampled in all types of vegetation in an attempt to obtain a complete picture of the diversity of plant associations on the Recreation Area, both naturally-occurring and those originating from human activity. These included early seral associations on shifting sand, plantations, stands dominated by introduced species, and natural forest stands more than 600 years old. All vegetation and plot location data are on file at the headquarters of the Siuslaw National Forest, in Corvallis, Oregon.

Table 2. Site productivity for selected tree species on soils occurring in the Oregon Dunes National Recreation Area. From Patching (1987) and Haagen (1989).

Soil type	Tree species	Mean site index	Site index curve (yr)
Bandon	Douglas fir	137-138	100
	Douglas fir	105	50
Blacklock	Shore pine	90	100
Bullards	Douglas fir	144	100
Netarts	Douglas fir	80-124	100
	Douglas fir	100	50
Salander	Sitka spruce	180	100
Templeton	Sitka spruce	169-180	100
	Douglas fir	170	100
Waldport	Shore pine	90-92	100

In 1987, twelve permanent transects were installed in the Recreation Area, each extending from foredunes or deflation plains inland to the edge of the forest. They were placed subjectively, to capture a cross-section of herbaceous and shrubby vegetation types, including ecotonal areas between beaches and forest, as well as to cover any potential variability throughout the length of the Recreation Area. The transects were intended to identify gradients between plant associations, and to monitor long-term changes to vegetation due to succession and shifting sand. Changes in vegetation were recorded along each transect, using the vegetation/landform mapping units of Pinto et al. (1972), and three plots

overing 1m² each (hereafter called "**transect plots**") were sampled in each mapping unit. A total of 330 transect plots were sampled. The ends of each transect were marked with reinforcing bar and PVC pipe, and marked on air photos and maps. A hand-held global positioning satellite receiver was used later to obtain coordinates for both the end points of each transects, as well as some of the boundaries of each landform type along each transect.

A second series of plots (hereafter called "**recon plots**") were designed to sample larger areas, particularly shrub and forest associations. A total of 290 recon plots were sampled between 1987 and 1993, allowing a relatively rapid assessment of vegetation diversity. Plots of 500 m² were used for most stands. Some wetland associations required smaller plots of 10-50 m², because of limited size or linear configuration around bodies of water. Selection of plot sizes were based upon published literature of species-area curves for different vegetation types (Mueller-Dombois and Ellenberg 1974; Bonham 1989; Krebs 1989), and upon our own experience of working in these plant associations. Plots were placed subjectively in more or less uniform stands of vegetation, avoiding obvious ecotonal features (Mueller-Dombois and Ellenberg 1974). We tried to sample discrete associations of plants, repeated elsewhere in the landscape, and tried to avoid obvious ecotonal areas. Using this method, sampling some ecotonal plots could not be avoided. Locations were recorded on aerial photographs, but not marked permanently in the field.

Variables for which data were collected in transect plots and recon plots are described in Appendix 1.

Data analysis. Because of the differences in plot size and environmental data gathered in each, data from recon plots and transect plots were analyzed separately. Plots were grouped into plant associations using the clustering programs SYN-TAX (Podani 1990) and TWINSpan (Hill 1979), and were further segregated by analysis of association tables generated by ECOAID (Smith 1993). In all cases, ECOAID was used to average cover values for all plots within a plant association, rather than for only those plots in which specific taxa occurred. CANOCO (ter Braak 1988) was used to ordinate data from recon plots, to help identify environmental gradients influencing distribution of vegetation. Data from transect plots were not ordinated, because few environmental variables were recorded when vegetation was sampled.

Because recon plots covered a larger area than transect plots, and offered more environmental data, we used them for most descriptive purposes, except in cases where the only data available were from transect plots. Many of the transect plots occurred in ecotonal areas, and did not sort well in the cluster analysis. Data from transect plots were used to corroborate differences observed in recon plots, and in most cases the groupings in each plot type were similar.

Botanical nomenclature. Scientific names used in this guide follow the PLANTS database for vascular plants (USDA, NRCS 1997), Esslinger and Egan (1995) for lichens, and Anderson (1990) and Anderson et al. (1990) for mosses. The species codes are those used in the PLANTS database.

Classification concepts. Construction of a vegetation classification for the Recreation Area was challenging because of the unique dynamics of the sand dune ecosystem. Countless local episodes of sand destabilization by wind, fire and tectonic disturbance have created complex patterns of both landform and vegetation, many of which occur side-by-side in small areas.

Our vegetation classification for the Recreation Area is structured to conform with the National Vegetation Classification System (NVCS) currently in preparation (Federal Geographic Data Committee

1996; Anderson et al. 1998; Grossman et al. 1998). The NVCS is a hierarchical classification designed to standardize vegetation classification in the United States. To date, multiple approaches by multiple agencies, each driven by differing classification philosophies and program needs, have produced a variety of classification schemes with little conformity between them. The NVCS employs a nested system of seven higher-order physiognomic ranks, derived from previous classifications by UNESCO (1973) and Driscoll et al. (1984), and two lower-order floristic ranks (Anderson et al. 1998; Grossman et al. 1998). It accommodates both natural and human-influenced associations, including plantations and stands dominated by introduced species.

Like the vegetation classification developed for Alaska (Viereck et al. 1992), the NVCS classification focuses on existing vegetation types, de-emphasizing climax or potential vegetation types. The concept of climax associations is difficult to apply in the Recreation Area, because of the pervasive threat of burial by sand, erosion of previously stabilized surfaces by wind, proximity to salt spray, and the uncertainty of some successional pathways. The majority of stands sampled in the study area are early seral to mid-seral associations, and the environmental stability needed for late seral or old-growth types is rare.

The NVCS uses the plant association as the basic unit of classification (Federal Geographic Data Committee 1996). The associations are named after one or more diagnostic species in each vegetation layer. These associations are grouped under alliances, named by one or more diagnostic species occurring in the uppermost layer. Plant associations are assemblages of plants that occur together at specific sites, identified by variables defining species composition and structure. They share one or more diagnostic overstory and understory species, and occur as repeatable patterns of assemblages across the landscape (Johnson and Clausnitzer 1992; Shephard 1995; Federal Geographic Data Committee 1996). Stands in a given association need not have identical species composition or environmental parameters (Thilenius 1995). The species-based approach to naming associations and alliances helps to identify specific units of vegetation on the ground. It differs from some approaches that have used landforms to classify dune vegetation, such as the "dune mat" and "dune hollow" associations of Duebendorfer (1990, 1992) and Pickart (1987, 1990).

Many wetland species tend to form monotypic stands over relatively large areas, but they are also capable of forming mixed stands with other types. In these cases, we recognize the monotypic expression of these species as plant associations, and consider the mixed stands to be ecotones. Some researchers would sample these mixed stands as single units, and would lump several types that we would recognize as being distinct.

RESULTS

Classification of plant associations. We identified 52 plant associations from the Recreation Area (Table 3). A few associations were not sampled in the field; these are included in Table 3, the identification key, and have brief association descriptions, but most are not included in the successional schemes. Summary data for both recon and transect plots are given in Appendix 1 and Appendix 2. Five vegetation classes, defined by the National Vegetation Classification System, are present on the Recreation Area: forest, woodland, shrubland, dwarf-shrubland, and herbaceous vegetation. Forest is represented by eight alliances, containing 13 forest associations, dominated by either Port Orford cedar, Sitka spruce, Douglas fir, western hemlock, shore pine, or red alder, with two additional wetland shore pine and Sitka spruce alliances. Woodland is represented by one alliance with three associations, all

dominated by shore pine. Five shrub alliances include six associations, dominated by either Scots pine, tree lupine, Hooker willow, or Douglas spiraea. Dwarf-shrub has two alliances with three associations, all dominated by bog blueberry. Herbaceous vegetation is represented by 27 alliances, containing 31 associations, ranging from dry dunes to both fresh and saltwater wetlands.

Ordination of plant associations. Ordination of the 1993 plot data, containing the most complete set of environmental variables, shows clear distinctions between forest and herbaceous dune associations, and between upland and wetland associations (Fig. 9). The horizontal axis is characterized by a gradient from bare sand (right side) to vegetated sand (left side), with a corresponding increase from right to left in shading, soil development, nutrient status, stand structure, and age. The vertical axis is characterized by a moisture gradient, dry at the top and wet at the bottom, with a corresponding increase from top to bottom in vegetative cover, soil development, nutrient status, and stand structure. Slope, aspect, total moss cover, and cover of tall shrubs are most important in well-developed, well-drained forest stands. Cover of low shrubs is greatest in wetland shrub associations.

Tree growth rate, stand structure, and successional status. Current growth data from forest stands, expressed in 20ths of an inch for the most recent ten years of radial growth, reveal the growth rate of individual species in different stands (Table 4). These data, together with relative amounts live and dead basal area (Fig. 10), give some indication of successional trends in forest and woodland on the Recreation Area. Figure 10 shows that tree height rarely exceeds 100 feet, and live basal area probably never exceeds 150 ft² per acre. Limitation of tree height and live basal area is presumably attributable to dry soils, low nutrient status, high winds, and salt spray in the dune environment. Higher dead basal area on the Recreation Area is generally correlated with mid-seral to climax status.

Wetlands. Wetlands, occupying about 20 percent of the Recreation Area, account for half the plant associations present. Water regimes present are identified at the alliance rank in Table 3, and are defined in Cowardin et al. (1979). Water regimes for tidal wetlands include regularly flooded ("low salt marsh") and irregularly flooded ("high salt marsh"). Freshwater regimes include permanently flooded, semipermanently flooded, seasonally flooded, saturated, and temporarily flooded. Three of the 13 forest associations, one of the three woodland associations, four of the six shrubland associations, both dwarf-shrubland associations, and 22 of the 31 herbaceous associations are wetlands. Although most wetland species are circumboreal or cosmopolitan in distribution, plant associations dominated by particular species tend to be more restricted in range, because of regional differences in species composition. While most wetland associations present on the Recreation Area are widespread in the Pacific Northwest, a few have a more restricted distribution. The wetland associations on deflation plains have some of the highest diversity of plant species in the Recreation Area (Table 5). High species diversity is correlated with high light levels, areas of bare sand available for seasonal colonization by annuals and biennials, and a seasonally-fluctuating water regime that allows for favorable germination and establishment.

Table 3. Classification of plant associations recorded from the Oregon Dunes National Recreation Area, based on National Vegetation Classification System (NVCS). For the purposes of this guide, we have substituted the scientific plant names with common names. Some of these associations have not yet been incorporated into the NVCS. Species codes are defined in Appendix 3.

Forest (Trees with crowns overlapping, generally 60-100 % cover)

Evergreen forest (Evergreen species generally > 75 % total tree cover)

Upland

PORT ORFORD CEDAR FOREST ALLIANCE

Port Orford cedar/evergreen huckleberry forest (CHLA/VAOV2)

SITKA SPRUCE FOREST ALLIANCE

Sitka spruce/salal forest (PISI/GASH)

Sitka spruce/salal-salmonberry forest (PISI/GASH-RUSP)

Sitka spruce/sword fern forest (PISI/POMU)

Sitka spruce/evergreen huckleberry forest (PISI/VAOV2)

DOUGLAS FIR GIANT FOREST ALLIANCE

Douglas fir/western rhododendron-evergreen huckleberry forest (PSME/RHMA3-VAOV2)

WESTERN HEMLOCK GIANT FOREST ALLIANCE

Western hemlock/western rhododendron-evergreen huckleberry forest (TSHE/RHMA3-VAOV2)

SHORE PINE FOREST ALLIANCE

Shore pine-Sitka spruce/evergreen huckleberry forest (PICOC-PISI/VAOV2)

Shore pine-Douglas fir/wax myrtle-evergreen huckleberry forest (PICOC-PSME/MYCA-VAOV2)

Shore pine/Scots broom/European beachgrass forest (PICOC/CYSC4/AMAR4)

Seasonally flooded

SHORE PINE SEASONALLY FLOODED FOREST ALLIANCE

Shore pine/slough sedge forest (PICOC/CAOB3)

Saturated

SITKA SPRUCE SATURATED FOREST ALLIANCE

Sitka spruce-red alder/slough sedge-skunk cabbage forest (PISI-ALRU/CAOB3-LYAM3)

Deciduous forest (Deciduous species generally > 75 % of total tree cover)

Saturated

RED ALDER SATURATED FOREST ALLIANCE

Red alder/salmonberry/slough sedge-skunk cabbage forest (ALRU/RUSP/CAOB3-LYAM3)

Woodland (Open stands with crowns not usually touching, generally forming 25-60 % cover, sometimes less)

Evergreen woodland (evergreen species generally > 75 % of total tree cover)

Upland

SHORE PINE WOODLAND ALLIANCE

Shore pine/hairy manzanita woodland (PICOC/ARCO3)

Shore pine/bearberry woodland (PICOC/ARUV)

Shrubland (> 0.5 m tall, generally > 25 % cover; tree cover generally < 25 %)

Deciduous shrubland (deciduous species generally > 75% of total shrub cover)

Upland

TREE LUPINE SHRUBLAND ALLIANCE

Tree lupine/European beachgrass shrubland (LUAR/AMAR4)

Seasonally flooded

HOKER WILLOW SEASONALLY FLOODED SHRUBLAND ALLIANCE

Hooker willow/slough sedge-Pacific silverweed shrubland (SAHO/CAOB3-AREGE)

Saturated

DOUGLAS SPIRAEA SATURATED SHRUBLAND ALLIANCE

Douglas spiraea shrubland (SPDO)

HOKER WILLOW SATURATED SHRUBLAND ALLIANCE

Hooker willow-crabapple/slough sedge-skunk cabbage shrubland (SAHO-MAFU/CAOB3-LYAM3)

dwarf-shrubland (shrubs < 2 feet tall, generally > 25 % cover; tree cover generally < 25 %)

Deciduous dwarf-shrubland

Seasonally flooded

BOG BLUEBERRY SEASONALLY FLOODED DWARF-SHRUBLAND ALLIANCE

Bog blueberry/slough sedge dwarf-shrubland (VAUL/CAOB3)

Bog blueberry/tufted hairgrass dwarf-shrubland (VAUL/DECEC)

Herbaceous vegetation (graminoids, forbs and ferns generally > 25 % cover; trees and shrubs generally < 25 % cover)

Perennial graminoid vegetation (generally > 50% of total herbaceous cover)

Upland

EUROPEAN BEACHGRASS HERBACEOUS ALLIANCE

European beachgrass herbaceous vegetation (AMAR4)

AMERICAN DUNEGRASS HERBACEOUS ALLIANCE

American dunegrass herbaceous vegetation (LEMOM2)

RED FESCUE HERBACEOUS ALLIANCE

Red fescue herbaceous vegetation (FERU2)

Red fescue-salt rush herbaceous vegetation (FERU2-JULE)

Red fescue-bracken fern herbaceous vegetation (FERU2-PTAQ)

SALT RUSH HERBACEOUS ALLIANCE

Salt rush herbaceous vegetation (JULE)

SICKLE-LEAVED RUSH HERBACEOUS ALLIANCE

Sickle-leaved rush-salt rush herbaceous vegetation (JUFA-JULE)

SEASHORE BLUEGRASS HERBACEOUS ALLIANCE

Seashore bluegrass herbaceous vegetation (POMA26)

Seasonally flooded

SLOUGH SEDGE SEASONALLY FLOODED HERBACEOUS ALLIANCE

Slough sedge seasonally flooded herbaceous vegetation (CAOB3)

Slough sedge-Pacific silverweed herbaceous vegetation (CAOB3-AREGE)

INFLATED SEDGE SEASONALLY-FLOODED HERBACEOUS ALLIANCE

Inflated sedge herbaceous vegetation (CAEX5)

THREEWAY SEDGE SEASONALLY FLOODED HERBACEOUS ALLIANCE

Threeway sedge herbaceous vegetation (DUAR3)

CREEPING SPIKERUSH SEASONALLY FLOODED HERBACEOUS ALLIANCE

Creeping spikerush-Nevada rush herbaceous vegetation (ELPA3-JUNE)

KNOTGRASS SEASONALLY FLOODED HERBACEOUS ALLIANCE

Knotgrass herbaceous vegetation (PADI6)

HARDSTEM BULRUSH SEASONALLY FLOODED HERBACEOUS ALLIANCE

Hardstem bulrush herbaceous vegetation (SCACA)

Tidally flooded

CREEPING BENTGRASS IRREGULARLY FLOODED TIDAL HERBACEOUS ALLIANCE

Creeping bentgrass-Pacific silverweed tidal herbaceous vegetation (AGSTS-AREGE)

LYNGBY SEDGE REGULARLY FLOODED TIDAL HERBACEOUS ALLIANCE

Lyngby sedge-Pacific silverweed tidal herbaceous vegetation (CALY3-AREGE)

TUFTED HAIRGRASS IRREGULARLY FLOODED TIDAL HERBACEOUS ALLIANCE

Tufted hairgrass-Pacific silverweed tidal herbaceous vegetation (DECEC-AREGE)

SALTGRASS REGULARLY FLOODED TIDAL HERBACEOUS ALLIANCE

Saltgrass-Pacific silverweed tidal herbaceous vegetation (DISP-AREGE)

BALTIC RUSH IRREGULARLY FLOODED TIDAL HERBACEOUS ALLIANCE

Baltic rush-Pacific silverweed tidal herbaceous vegetation (JUBA-AREGE)

THREE-SQUARE BULRUSH REGULARLY FLOODED TIDAL HERBACEOUS ALLIANCE

Three-square bulrush tidal herbaceous vegetation (SCAM6)

Perennial forb vegetation, including ferns (generally > 50% total herbaceous cover)

Upland

SEASHORE LUPINE HERBACEOUS ALLIANCE

Seashore lupine herbaceous vegetation (LULI2)

Seasonally flooded

WATERPEPPER SEASONALLY FLOODED HERBACEOUS ALLIANCE

Waterpepper-water purslane herbaceous vegetation (POHY2-LUPA)

- Semipermanently flooded
- FLOATING WATER-PENNYWORT SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE
 - Floating water-pennywort herbaceous vegetation (HYRA)
 - POND LILY SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE
 - Pond lily herbaceous vegetation (NULUP)
 - WATER SMARTWEED SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE
 - Water smartweed herbaceous vegetation (POAM8)
 - FLOATING-LEAVED PONDWEED SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE
 - Floating-leaved pondweed herbaceous vegetation (PONA4)
 - SIMPLESTEM BUR-REED SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE
 - Simplestem bur-reed herbaceous vegetation (SPAN2)
- Hydromorphic rooted vegetation (non-emergent graminoids or forbs structurally supported by water)
- Permanently flooded
- SOUTH AMERICAN WATERWEED PERMANENTLY FLOODED HERBACEOUS ALLIANCE
 - South American waterweed herbaceous vegetation (EGDE)
 - PARROT-FEATHER PERMANENTLY FLOODED HERBACEOUS ALLIANCE
 - Parrot-feather herbaceous vegetation (MYAQ2)
 - COMMON BLADDERWORT PERMANENTLY FLOODED HERBACEOUS ALLIANCE
 - Common bladderwort herbaceous vegetation (UTMA)

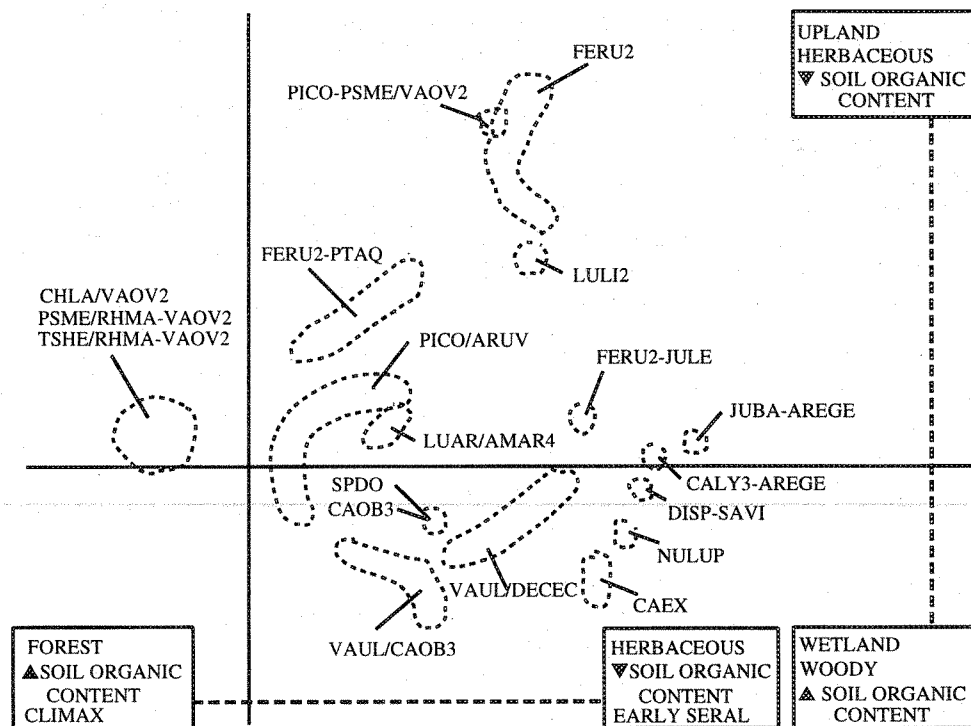


Fig. 9. Ordination of selected plant associations, Oregon Dunes National Recreation Area. Species codes are defined in Appendix 3.

Table 4. Current growth (last 10 yr of radial growth, in 20ths of an inch) for trees sampled in recon plots in Oregon Dunes National Recreation Area. Species codes are defined in Appendix 3.

Plant association	Species	Curr. growth (mean)	No. trees sampled
LRU/RUSP/CAOB3-LYAM3	ALRU	33 (33)	1
HLA/VAOV2	CHLA	2-10 (6)	8
	PISI	2-24 (12)	5
	PICOC	8 (8)	2
	PSME	4-15 (9)	5
	TSHE	12-14 (13)	2
ICOC/ARCO3	PICOC	6-13 (9)	4
	PSME	22-23 (23)	2
ICOC/ARUV	PICOC	6-10 (8)	6
ICOC/CAOB3	PISI	16 (16)	1
	PICOC	6-22 (12)	4
ICOC/CYSC4/AMAR4	PICOC	7-61 (30)	5
	PSME	56 (56)	1
ISI-PICOC/VAOV2	PISI	6-46 (17)	13
	PICOC	7-44 (18)	16
	PSME	13-35 (23)	3
	TSHE	15 (15)	1
ICOC-PSME/MYCA-VAOV2	PISI	16 (16)	1
	PICOC	3-21 (8)	16
	PSME	2-42 (11)	13
	TSHE	20 (20)	1
ISI/GASH-RUSP	PISI	21 (21)	1
ISI/GASH	PISI	21	1
ISI/VAOV2	PISI	2-27 (13)	13
	PICOC	7 (7)	1
	PSME	6-30 (15)	3
	THPL	11 (11)	1
	TSHE	6-8 (7)	2
PSME/RHMA3-VAOV2	PISI	26 (26)	1
	PICOC	4-14 (8)	4
	PSME	2-18 (8)	13
	THPL	17-20 (19)	2
TSHE/RHMA3-VAOV2	PISI	2-78 (21)	8
	PSME	2-10 (6)	12
	THPL	8-27 (14)	6
	TSHE	5-33 (14)	9

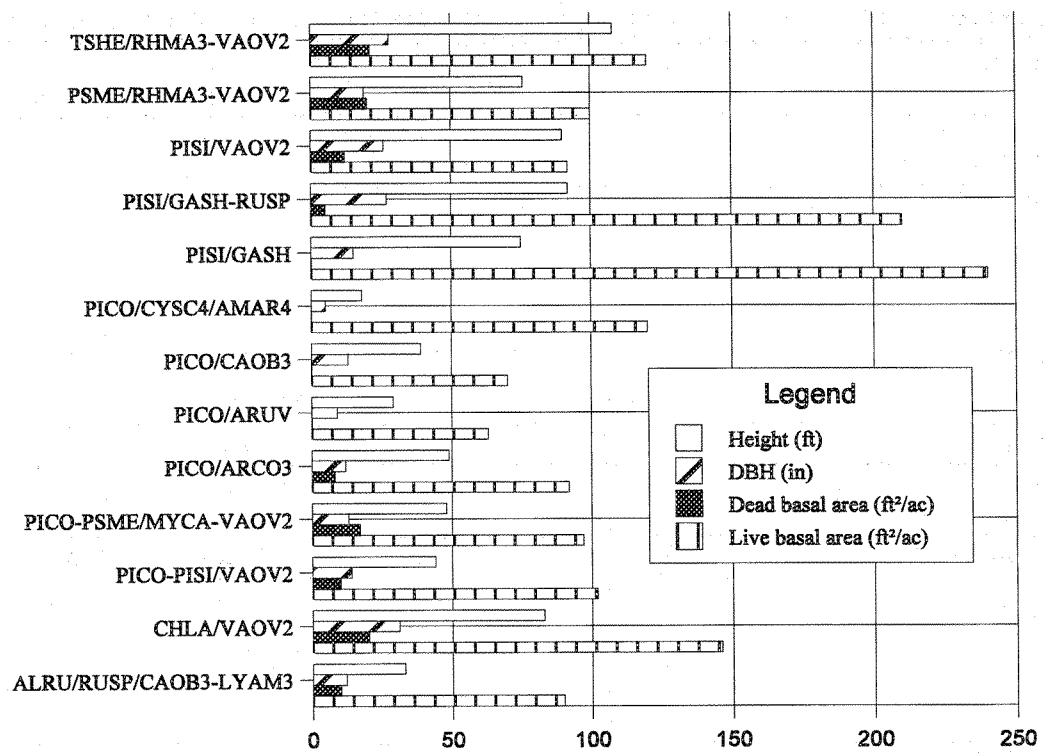


Fig. 10. Forest and woodland tree structure, Oregon Dunes National Recreation Area.

Table 5. Number of plant species recorded in plots sampled on Oregon Dunes National Recreation Area, by layer. (n) = number of recon plots.

	Overstory trees	Understory trees	Shrubs & woody groundcover	Herbs, ferns & graminoids
Forest				
ALRU/RUSP/CAOB3-LYAM3 (2)	3	4	10	7
CHLA/VAOV2 (11)	6	8	7	9
PICOC/CAOB3 (6)	2	3	10	24
PICOC/CYSC4/AMAR4 (14)	3	4	9	31
PICOC-PSME/MYCA-VAOV2 (15)	4	5	11	8
PISI/GASH (1)	1	1	2	5
PISI/GASH-RUSP (4)	3	4	6	9
PISI-PICOC/VAOV2 (12)	5	7	13	19
PISI/VAOV2 (14)	6	6	9	12
PSME/RHMA3-VAOV2 (11)	4	5	8	8
TSHE/RHMA3-VAOV2 (16)	6	6	9	10
Woodland				
PICOC/ARCO3 (5)	2	2	7	10
PICOC/ARUV (11)	3	5	7	18
Shrubland				
LUAR/AMAR4 (2)	0	2	8	24
SAHO-MAFU/CAOB3-LYAM3 (2)	3	0	8	12
SAHO/CAOB3-AREGE (18)	2	3	11	42
SPDO (1)	0	0	2	4
Dwarf-shrubland				
VAUL/CAOB3 (10)	1	3	10	32
VAUL/DECEC (3)	1	3	5	26
Herbaceous				
AGSTS-AREGE	0	0	0	8
AMAR4 (16)	1	2	9	44
CALY3-AREGE (4)	0	0	0	22
CAEX5 (3)	0	0	2	12
CAOB3 (1)	0	0	0	0
CAOB3-AREGE (15)	1	2	8	54
DISP-AREGE (6)	0	0	0	23
ELPA3-JUNE (11)	0	0	5	49
FERU2 (9)	0	2	1	17
FERU2-JULE (6)	0	3	6	52
FERU2-PTAQ (3)	0	1	2	8
JUBA-AREGE (1)	0	0	0	8
JUFA-JULE (10)	1	2	7	48
JULE (7)	1	2	7	52
LEMOM2 (4)	0	1	4	28
LULI2 (4)	0	0	0	16
NULUP (1)	0	0	1	11
POMA26 (1)	0	0	0	5
PONA4 (1)	0	0	0	6
SCACA (1)	0	0	2	3
SCAM6 (3)	0	0	1	16
SPAN2 (1)	0	0	0	5

KEY TO PLANT ASSOCIATIONS OF THE OREGON DUNES NATIONAL RECREATION AREA

1a. Tree species (any layer) generally > 60 % cover [FOREST ASSOCIATIONS]	5 (p. 33)
1b. Tree species (any layer) generally < 60 % cover	2
2a. Tree species (any layer) generally 25-60 % cover [WOODLAND ASSOCIATIONS]	17 (p. 34)
2b. Tree species (any layer) generally < 25 % cover	3
3a. Shrubs > 25 % cover	4
3b. Shrubs < 25 % cover [HERBACEOUS ASSOCIATIONS]	31 (p. 35)
4a. Mature shrubs over 2 ft tall [SHRUBLAND ASSOCIATIONS]	24 (p. 35)
4b. Mature shrubs under 2 ft tall [DWARF-SHRUBLAND ASSOCIATIONS]	29 (p. 35)

FOREST ASSOCIATIONS

5a. Red alder > 20 % cover	6
..... Red alder/salmonberry/slough sedge-skunk cabbage saturated forest (p. 64)	
5b. Red alder < 20 % cover	6
6a. Port Orford cedar (any layer) > 10 % cover	
..... Port Orford cedar/evergreen huckleberry forest (p. 40)	
6b. Port Orford cedar (any layer) < 10 % cover	7
7a. Western hemlock or Douglas fir (any layer) > 20 % cover	8
7b. Western hemlock or Douglas fir (any layer) < 20 % cover	10
8a. Western hemlock (any layer) > 20 % cover	
..... Western hemlock/western rhododendron-evergreen huckleberry forest	(p. 52)
8b. Western hemlock (any layer) < 20 % cover	9
9a. Shore pine (any layer) > 20 % cover	
..... Shore pine-Douglas fir/wax myrtle-evergreen huckleberry forest (p. 56)	
9b. Shore pine (any layer) < 20 % cover	
..... Douglas fir/western rhododendron-evergreen huckleberry forest (p. 50)	
10a. Of conifers present (any layer), Sitka spruce only one > 20 % cover	11
10b. Sitka spruce and shore pine (any layer) both > 20 % cover, or of conifers present (any layer), shore pine only one > 20 % cover	15
11a. Evergreen huckleberry > 10 % cover	
..... Sitka spruce/evergreen huckleberry forest (p. 48)	
11b. Evergreen huckleberry < 10 % cover	12

12a. Skunk cabbage > 10 % cover	.....	Sitka spruce-red alder/slough sedge-skunk cabbage forest (p. 62)
12b. Skunk cabbage < 10 % cover	.....	13
13a. Salmonberry > 10 % cover	.....	Sitka spruce/salal-salmonberry forest (p. 44)
13b. Salmonberry < 10 % cover	.....	14
14a. Salal > 10 % cover	.....	Sitka spruce/salal forest (p. 46)
14b. Salal < 10 % cover	.....	Sitka spruce/sword fern forest (p. 42)
15a. Sitka spruce and shore pine (any layer) both > 20 % cover	.....	Shore pine-Sitka spruce/evergreen huckleberry forest (p. 54)
15b. Of conifers present (any layer), shore pine only one > 20 % cover	.....	16
16a. Slough sedge > 10 % cover, European beachgrass < 10 % cover	.....	Shore pine/slough sedge forest (p. 60)
16b. Slough sedge < 10 % cover, European beachgrass > 10 % cover	.....	Shore pine/Scots broom/European beachgrass forest (p. 58)

WOODLAND ASSOCIATIONS

17a. Of conifers present (any layer), shore pine only one > 20 % cover	.....	18
17b. Shore pine with either Douglas fir or Sitka spruce (any layer) > 20 % cover	.....	21
18a. Shrub layer with hairy manzanita or bearberry	.....	19
18b. Shrub layer lacking hairy manzanita or bearberry	.....	20
19a. Hairy manzanita > 10 % cover, bearberry < 10 % cover	.....	Shore pine/hairy manzanita woodland (p. 70)
19b. Hairy manzanita < 10 % cover, bearberry > 10 % cover	.....	Shore pine/bearberry woodland (p. 68)
20a. Slough sedge > 10 % cover, European beachgrass < 10 % cover	.....	see Shore pine/slough sedge forest (p. 60)
20b. Slough sedge < 10 % cover, European beachgrass > 10 % cover	.....	see Shore pine/Scots broom/European beachgrass forest (p. 58)
21a. Shore pine (any layer) > 20% cover	.....	22
21b. Shore pine (any layer) < 20 % cover	.....	23
22a. Douglas fir (any layer) > 20 % cover	.....	see Shore pine-Douglas fir/wax myrtle-evergreen huckleberry forest (p. 56)
22b. Sitka spruce (any layer) > 20 % cover	.....	see Shore pine-Sitka spruce/evergreen huckleberry forest (p. 54)

32a. Cover of grasses > cover of other graminoids	33
32b. Cover of grasses < cover of other graminoids	42
33a. Red fescue > cover of other grass species	34
33b. Red fescue < cover of other grass species	36
34a. Bracken fern > 10 % cover Red fescue-bracken fern herbaceous vegetation (p. 98)	
34b. Bracken fern < 10% cover	35
35a. Total herb cover < 30 %; upland dunes; beach knotweed, seashore bluegrass, seashore lupine and beach silvertop frequent associates	
..... Red fescue herbaceous vegetation (p. 94)	
35b. Total herb cover > 30 %; deflation plains; salt rush, little hairgrass, European centaury, Nevada rush, tufted hairgrass and velvet grass frequent associates	
..... Red fescue-salt rush herbaceous vegetation (p. 96)	
36a. Upland dunes; well-drained	37
36b. Deflation plain; often with seasonal flooding	39
37a. European beachgrass > 20 % cover	
..... European beachgrass herbaceous vegetation (p. 90)	
37b. European beachgrass < 20 % cover	38
38a. American dunegrass > 10 % cover, seashore bluegrass < 10 % cover	
..... American dunegrass herbaceous vegetation (p. 92)	
38b. American dunegrass < 10 % cover, seashore bluegrass > 10 % cover	
..... Seashore bluegrass herbaceous vegetation (p.104)	
39a. Saltgrass > 20 % cover	
..... Saltgrass-Pacific silverweed tidal herbaceous vegetation (p. 124)	
39b. Saltgrass < 20 % cover	40
40a. Creeping bentgrass > 20 % cover	
..... Creeping bentgrass-Pacific silverweed tidal herbaceous vegetation (p. 118)	
40b. Creeping bentgrass < 20 % cover	41
41a. Tufted hairgrass > 20 % cover, knotgrass < 20 % cover	
..... Tufted hairgrass-Pacific silverweed tidal herbaceous vegetation (p. 122)	
41b. Tufted hairgrass < 20 %, knotgrass > 20 % cover	
..... Knotgrass herbaceous vegetation (p. 114)	
42a. Cover of sedges > cover of other graminoids	43
42b. Cover of sedges < cover of other graminoids	46
43a. Lyngby sedge > 20 % cover	
..... Lyngby sedge-Pacific silverweed tidal herbaceous vegetation (p. 120)	
43b. Lyngby sedge < 20 % cover	44

44a. Slough sedge > 20 % cover	45
44b. Slough sedge < 20 % cover	Inflated sedge herbaceous vegetation (p. 110)
45a. Pacific silverweed > 10 % cover	
.....	Slough sedge-Pacific silverweed herbaceous vegetation (p. 108)
45b. Pacific silverweed < 10 % cover	
.....	Slough sedge seasonally flooded herbaceous vegetation (p. 106)
46a. Cover of rushes > cover of other graminoids	47
46b. Cover of rushes < cover of other graminoids	49
47a. Salt rush present	48
47b. Salt rush absent	Baltic rush-Pacific silverweed tidal herbaceous vegetation (p. 126)
48a. Sick-leaved rush > 10 % cover	
.....	Sickle-leaved rush-salt rush herbaceous vegetation (p. 102)
48b. Sick-leaved rush < 10 % cover	Salt rush herbaceous vegetation (p. 100)
49a. Cover of bulrushes > cover of other graminoids	50
49b. Cover of bulrushes < cover of other graminoids	51
50a. Hardstem bulrush > 20 % cover, three-square bulrush < 20 % cover	
.....	Hardstem bulrush herbaceous vegetation (p. 116)
50b. Hardstem bulrush < 20 % cover, three-square bulrush > 20 % cover	
.....	Three-square bulrush tidal herbaceous vegetation (p. 128)
51a. Threeway sedge > 20 % cover	Threeway sedge herbaceous vegetation (p. 111)
51b. Threeway sedge < 20 % cover	52
52a. Creeping spikerush > 20 % cover, simplestem bur-reed < 20 % cover	
.....	Creeping spikerush-Nevada rush herbaceous vegetation (p. 112)
52b. Creeping spikerush < 20 % cover, simplestem bur-reed > 20 % cover	
.....	Simplestem bur-reed herbaceous vegetation (p. 138)
53a. Seashore lupine present; upland dunes	Seashore lupine herbaceous vegetation (p. 130)
53b. Seashore lupine absent; permanently or seasonally flooded wetlands	54
54a. Leaves entire, > 1 inch diameter	55
54b. Leaves finely dissected, < 1 inch diameter	59
55a. Waterpepper or water smartweed present	56
55b. Waterpepper or water smartweed absent	57
56a. Waterpepper > 20 % cover, water smartweed < 20 % cover	
.....	Waterpepper-water purslane herbaceous vegetation (p. 131)
56b. Waterpepper < 20 % cover, water smartweed > 20 % cover	
.....	Water smartweed herbaceous vegetation (p. 133)

57a. Floating water-pennywort > 20 % cover	
.....	Floating water-pennywort herbaceous vegetation (p. 132)
57b. Floating water-pennywort < 20 % cover	58
58a. Floating-leaved pondweed > 20 % cover, pond lily < 20 % cover	
.....	Floating-leaved pondweed herbaceous vegetation (p. 136)
58b. Floating-leaved pondweed < 20 % cover, pond lily > 20 % cover	
.....	Pond lily herbaceous vegetation (p. 134)
59a. South American waterweed > 20 % cover	
.....	South American waterweed herbaceous vegetation (p. 139)
59b. South American waterweed < 20 % cover	60
50a. Parrot-feather > 20 % cover, common bladderwort < 20 % cover	
.....	Parrot-feather herbaceous vegetation (p. 140)
50b. Parrot-feather < 20 % cover, common bladderwort > 20 % cover	
.....	Common bladderwort herbaceous vegetation (p. 141)

FOREST ASSOCIATIONS

Port Orford cedar/evergreen huckleberry forest (CHLA/VAOV2)	40
Sitka spruce/salal forest (PISI/GASH)	42
Sitka spruce/salal-salmonberry forest (PISI/GASH-RUSP)	44
Sitka spruce/sword fern forest (PISI/POMU)	46
Sitka spruce/evergreen huckleberry forest (PISI/VAOV2)	48
Douglas fir/western rhododendron-evergreen huckleberry forest (PSME/RHMA3-VAOV2)	50
Western hemlock/western rhododendron-evergreen huckleberry forest (TSHE/RHMA3-VAOV2)	52
Shore pine-Sitka spruce/evergreen huckleberry forest (PICOC-PISI/VAOV2)	54
Shore pine-Douglas fir/wax myrtle-evergreen huckleberry forest (PICOC-PSME/MYCA-VAOV2)	56
Shore pine/Scots broom/European beachgrass forest (PICOC/CYSC4/AMAR4)	58
Shore pine/slough sedge forest (PICOC/CAOB3)	60
Sitka spruce-red alder/slough sedge-skunk cabbage forest (PISI-ALRU/CAOB3-LYAM3)	62
Red alder/salmonberry/slough sedge-skunk cabbage forest (ALRU/RUSP/CAOB3-LYAM3)	64



Douglas fir/western rhododendron-evergreen huckleberry forest

PORT ORFORD CEDAR GIANT FOREST ALLIANCE

CHLA/VAOV2

PORT ORFORD CEDAR/EVERGREEN HUCKLEBERRY FOREST

Thuja plicata/*Vaccinium ovatum*



CHLA/VAOV2

(Sampled: 11 recon plots)

CTS404

Environment. This unique association occurs on narrow, dry stabilized dune ridges, troughs and seasonally dry deflation plains at the southern end of the Recreation Area, where less than 200 acres have been identified. All aspects and slopes are represented. Soils are poorly to moderately developed, from 0 to 12 inches deep.

Vegetation and ecology. Stands are dominated by a mixture of Port Orford cedar, Douglas fir and Sitka spruce. Cover of overstory trees varies from 20-90 percent, with an average of 64 percent. In this layer, Port Orford cedar is most abundant at 15-80 percent cover. Tree age varies from 150-350 years old, with diameters 12-61 inches. Live basal area for this association is the second largest recorded on the Recreation Area, averaging 146 ft² per acre. Large, horizontal branches with Scouler's polypody create good nesting structure for marbled murrelets. Many large Port Orford cedars have charred bark, and ages of fire-sensitive trees present suggest that stands were last burned about 80-100 years ago. Port Orford cedar reproduction occurs mostly at the edges of stands, where there is much edge effect. Shore pine occurs at the edges of the stands but is senescent in the interior. The shrub layer, dominated by evergreen huckleberry, has 60-95 percent cover, averaging 82 percent cover. Shrub height averages 9 feet. Because of dense shading, the herb layer is depauperate. Moss cover averages 27 percent, with *Plurynychium oregonum*, *Isoetes macrospora* and *Dicranum fuscum* being the most common species. Lichens are scarce except for a few *Usnea* and *Lepraria* on the trees. Egler (1934) noted that Port Orford cedar may survive sand burial by producing adventitious roots along the trunk.

Succession. Mid to late seral. Stands of this type replace the shore pine/hairy manzanita association, remnants of which persist around the edges of old-growth stands. Both Sitka spruce and western hemlock exhibit the greatest current growth in these stands (Table 4). If stands grow larger, with decreasing edge effect, they may be replaced by the western hemlock/western rhododendron-evergreen huckleberry association, or the Sitka spruce-evergreen huckleberry association. Proximity to salt spray may inhibit growth of hemlock, and lead to a Sitka spruce/evergreen huckleberry association.

Distribution and history. This association originally occurred along the coast between Port Orford and Winchester Bay, Oregon. Port Orford cedar has long been of great commercial value (Zobel 1986), and old-growth stands on sand dunes are exceedingly rare. On the Recreation Area, six old-growth stands are known, five between the Trans-Pacific Highway and Horsfall Road, and one east of Beale Lake. Hawk (1977) described two 40-50 year-old stands on dunes and deflation plains near Saunders Lake.

Management. Port Orford cedar is being decimated throughout its limited range by the fungal root rot *Phytophthora lateralis* (Zobel et al. 1985; Kliejunas 1994). The fungus spreads in the soil by water-borne spores, and is dispersed further by soil adhering to machinery and livestock. Droughty sand does not appear to inhibit dispersal of spores, as *Phytophthora* is killing trees in the dunes as well as on loamy soils farther inland. Stands should be managed to avoid any possibility of accidental introduction of the root rot fungus. All stands should be protected and monitored, and all motorized vehicles should be excluded. Hiking trails or viewing platforms are not recommended, as any intrusion may inadvertently introduce the root rot.

Other studies. Egler (1934) noted the presence of Port Orford cedar in the dunes, but not as an association. Hawk (1977) described a young Port Orford cedar-Sitka spruce association on dunes and deflation plains. Stand structure differed considerably from old-growth, but nearby stands 90-125 years old had a structure more similar to the Port Orford cedar/evergreen huckleberry association. Jimerson (1994) described a tanoak-Port Orford cedar/evergreen huckleberry association from gravelly loams in northern California, and Randall (1996) described a Port Orford cedar/evergreen huckleberry/sword fern association from southwestern Oregon. Stands on the Recreation Area differ from these significantly in species composition, and have much less sword fern.

Common plants of the Port Orford cedar/evergreen huckleberry association (n = 11 recon plots).

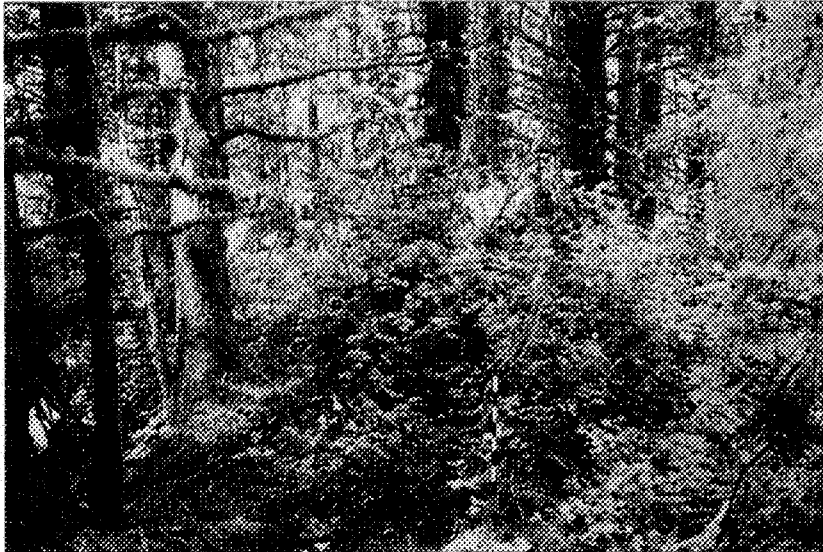
	Const.	Ave. cov. (%)	Range cov. (%)
OVERSTORY TREES			
Port Orford cedar	100	48	15-80
Douglas fir	82	10	0-25
Sitka spruce	73	11	0-50
Shore pine	55	5	0-30
Western hemlock	45	2	0-10
UNDERSTORY TREES			
Port Orford cedar	73	3	0-15
Douglas fir	45	1	0-3
Western hemlock	36	1	0-10
Sitka spruce	36	1	0-2
SHRUBS AND WOODY GROUNDCOVER			
Evergreen huckleberry	100	63	40-90
Salal	91	9	0-20
Wax myrtle	82	7	0-25
Western rhododendron	36	8	0-25
Red huckleberry	36	1	0-5
HERBS, FERNS AND GRAMINOIDS			
Bracken fern	64	1	0-5
Sword fern	27	Tr	0-1
Licorice fern	27	Tr	0-1
Deer fern	27	Tr	0-1

SITKA SPRUCE GIANT FOREST ALLIANCE

PISI/GASH
PISI/GASH-RUSP
PISI/POMU
PISI/VAOV2

SITKA SPRUCE/SALAL FOREST

Picea sitchensis/Gaultheria shallon



PISI/GASH
(Sampled: 1 recon plot)
CSS321

Environment. This association occurs on silt loam soils on Coast Range foothills along the eastern edge of the Recreation Area, the "mountain front" of Pinto et al. (1972). They are the most productive soils on the Recreation Area. Slopes are moderate to steep, and most aspects are represented. Soil depth varies from 6-40 inches deep, averaging about 15 inches.

Vegetation and ecology. The canopy is dominated by Sitka spruce, with an average cover of 85 percent. Most stands seen were either 50-75 year-old second growth, or had been selectively logged for red cedar prior to 1940, leaving Sitka spruce up to 200 years old. Like the Sitka spruce/salal-salmonberry association, this association differed significantly from those on sand dunes by its high canopy cover, high basal area, and low shrub cover. The shrub layer has been suppressed by the dense, even-aged canopy developed after logging. In the single stand sampled, moss cover on the ground was 15 percent, and ferns were absent. These stands are similar to the Sitka spruce/salal-salmonberry association, except that salmonberry is absent, and the herb and moss layers are depauperate. The exaggerated live basal area and lack of dead basal area shown in Fig. 10 is probably attributable to the small sample size.

Succession. Mid to late seral. Associations antecedent to this type were not sampled, but would probably be red alder types developed after fire or logging. Stands may eventually be replaced by the western hemlock alliance, but no older examples were found to sample on the Recreation Area.

Distribution and history. This association is common along the coast between northern California and British Columbia. On the Recreation Area, most stands occur on the silt loams of the Coast Range

foothills. Examples may be seen along the Siltcoos Lake Trail, and both north and south of Threemile Lake, along the Threemile Lake Trail.

Management. Well-developed soils render these sites the most productive on the Recreation Area for timber production. These stands are favored collecting areas for mushrooms, particularly chanterelle and lobster mushrooms. Mycorrhizae are plentiful, and visibility is good because of low shrub densities. Old-growth examples of this vegetation type have been decimated along the coast from a long history of logging. Holly and English ivy, both exotic species, are invading these stands in Oregon and Washington, and will become serious pests.

Other studies. Pinto et al. (1972) described other 12-60 year-old stands occurring on soils of the "mountain front," ranging from pure stands of Sitka spruce, western hemlock or Douglas fir, to mixtures of all three species, with pockets of western red cedar and shore pine. The Sitka spruce/salal association would have been one of these forest types. Hemstrom and Logan (1986) described a similar Sitka spruce/salal association, but with significantly greater shrub cover. On the Recreation Area, shrub cover will likely increase as stands mature and the canopy opens up, and this type will closely resemble that described by Hemstrom and Logan. Fong (1996) described a Sitka spruce/salal-evergreen huckleberry association from southwestern Oregon, but the species composition differs significantly from our Sitka spruce/salal association.

Common plants of the Sitka spruce/salal association (n = 1 recon plot).

	Const.	Ave. cov. (%)	Range cov. (%)
OVERSTORY TREES			
Sitka spruce	100	85	85
UNDERSTORY TREES			
Cascara	100	Tr	Tr
SHRUBS AND WOODY GROUNDCOVER			
Salal	100	5	5
Evergreen huckleberry	100	1	1
HERBS, FERNS AND GRAMINOIDS			
Candyflower	100	1	1
Field woodrush	100	1	1
Evergreen violet	100	1	1
Swamp bedstraw	100	1	1

SITKA SPRUCE/SALAL-SALMONBERRY FOREST

Picea sitchensis/Gaultheria shallon-Rubus spectabilis



PISI/GASH-RUSP
(Sampled: 4 recon plots)
CSS322

Environment. This association is best developed on silt loam soils on Coast Range foothills along the eastern edge of the Recreation Area, the "mountain front" of Pinto et al. (1972). These soils are the most productive on the Recreation Area. Slopes are moderate to steep, and most aspects are represented. Soil depth varies from 6-40 inches deep, averaging about 15 inches.

Vegetation and ecology. The canopy is dominated by Sitka spruce, with red cedar and western hemlock present in both the canopy and understory. Most stands seen were either 50-75 year-old second growth, or had been selectively logged for red cedar prior to 1940, leaving Sitka spruce up to 200 years old. These stands differed significantly from other forest associations on sand dunes by their high canopy cover, high basal area, high moss cover, and low shrub cover. Moss cover on the ground ranges from 55-70 percent, *Eurhynchium oregonum* being most abundant. Basal area is the highest recorded on the Recreation Area, averaging 216 ft² per acre. Cover of sword fern is the highest recorded in any plots sampled, and salmonberry and deer fern are conspicuous, indicating more mesic conditions than those occurring on sand. Evergreen huckleberry and salal have noticeably lower cover than in other forest plots on the Recreation Area, attributable to the dense, even-aged canopy developed after logging. Live basal area (Fig. 10) for the Sitka spruce/salal-salmonberry association is no doubt exaggerated because of small sample size.

Succession. Mid to late seral. Quaye (1982) considered this type to be transitional between the Sitka spruce/sword fern association and his western hemlock/salal/sword fern association. On the Recreation Area, shrub cover in these stands will likely increase as stands mature and the canopy opens up, and this type will closely resemble the Sitka spruce/salmonberry-salal association described by Hemstrom and Logan (1986).

Distribution and history. This association occurs along the coast between northern California and British Columbia. On the Recreation Area, most stands occur on the silt loams of the Coast Range foothills along the eastern edge of the Recreation Area. Good places to see examples of this association are along Siltcoos Lake Trail, and both north and south of Threemile Lake, along the Threemile Lake Trail.

Management. Well-developed soils render these sites the most productive on the Recreation Area for timber production. These stands are favored collecting areas for mushrooms, particularly chanterelle and lobster mushrooms. Mycorrhizae are plentiful, and visibility is good because of low shrub densities. Old-growth examples of this vegetation type have been decimated along the coast from a long history of logging. Holly and English ivy, both exotic species, are invading some of these stands and will become serious pests if not removed.

Other studies. Pinto et al. (1972) described 12-60 year-old forest stands occurring on soils of the "mountain front," ranging from pure Sitka spruce, western hemlock or Douglas fir, to mixtures of all three species, with pockets of western red cedar and shore pine. Sitka spruce/salal-salmonberry association would have been among these forest types. Quaye's (1982) Sitka spruce/sword fern-deer fern and Sitka spruce/salal/sword fern-deer fern associations are very similar to this association, but with somewhat higher fern cover. Wiedemann (1984, 1993) described a western hemlock-Sitka spruce/salal/deer fern association as a rare zonal or climatic climax on moister sites. Hemstrom and Logan (1986) described a similar Sitka spruce/ salmonberry-salal association, but with significantly greater shrub cover. The Sitka spruce/ salmonberry association described from Alaska by de Meo et al. (1992) and Boggs (1998) has a very different species composition, and lacks both salal and red cedar. Fong (1996) described a Sitka spruce/salal-evergreen huckleberry association from southwestern Oregon, but the species composition differs significantly from our Sitka spruce/salal-salmonberry association.

Common plants of the Sitka spruce/salal-salmonberry association (n = 4 recon plots).

	Const.	Ave. cov. (%)	Range cov. (%)
OVERSTORY TREES			
Sitka spruce	100	81	75-90
Western hemlock	80	11	5-15
Western red cedar	10	7	5-20
UNDERSTORY TREES			
Cascara	75	9	0-15
Western red cedar	50	1	0-3
Western hemlock	50	1	0-2
Sitka spruce	25	Tr	0-1
SHRUBS AND WOODY GROUNDCOVER			
Salal	100	19	5-35
Salmonberry	100	18	10-30
Evergreen huckleberry	100	5	4-5
Red huckleberry	100	5	2-10
Fool's huckleberry	75	3	0-5
Thimbleberry	75	2	0-2
HERBS, FERNS AND GRAMINOIDS			
Deer fern	100	9	1-25
Sword fern	100	6	1-10
Fairy lantern	75	1	0-1
Small-flowered woodrush	50	Tr	0-1

SITKA SPRUCE/SWORD FERN FOREST

Picea sitchensis/Polystichum munitum



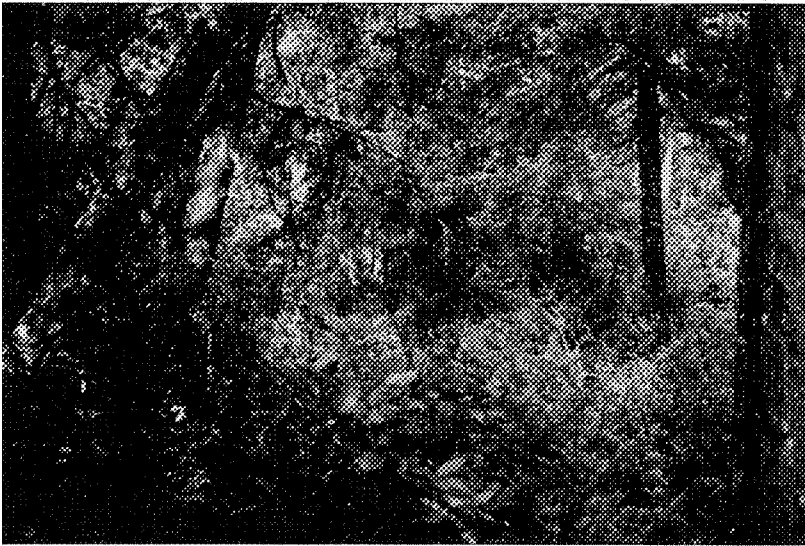
PISI/POMU
(Not sampled)
CSF121

This mid to late seral association was seen on the Recreation Area, but never sampled. It is dominated by second-growth Sitka spruce, on slopes of both the silt loams of the "mountain front" east of Highway 101, as well as older dunes north and south of Threemile Lake, along the Threemile Lake Trail. All slopes and aspects are represented, and soils may be well-developed. The association extends from northern California to British Columbia. Based on descriptions from other areas, canopy cover ranges from 60-85 percent. Sword fern may have up to 55 percent cover, and few shrubs are present. Quaye (1982) and Hemstrom and Logan (1986) described a Sitka spruce/sword fern association very similar to those seen on the Recreation Area. The Sitka spruce/sword fern association of Sawyer and Keeler-Wolf (1995) may be similar to this association. Of the spruce stands sampled by Quaye (1982), this association had the greatest basal area, and is highly productive.

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SITKA SPRUCE/EVERGREEN HUCKLEBERRY FOREST

Picea sitchensis/Vaccinium ovatum



PISI/VAOV2

(Sampled: 14 recon plots)

CSS101

Environment. This association occurs on dry ridgetops, slopes, deflation plains and floodplains in the dune sheet, usually near the ocean. It is a common component of tree islands. Most aspects are represented. Stands in elevated areas close to the ocean are subject to wind pruning, windthrow and salt damage. Soil contains little organic matter, ranging from one to six inches, averaging three inches.

Vegetation and ecology. Stands are dominated by Sitka spruce, with lesser amounts of Douglas fir and a senescing component of shore pine. The canopy is often open, averaging 60 percent cover, but ranging from 35-90 percent. Some stands contain spruce trees up to 450 years old, the oldest of this species seen on the Recreation Area. The shrub layer is dominated by evergreen huckleberry and salal, with one of the highest densities recorded in the Recreation Area, averaging 85 percent cover, with heights to 15 feet. Because of dense shade, the herb layer is depauperate, and the moss layer has moderately high cover, although much of it is obscured by shrubs. Live basal area is low, compared to most other dune associations. Stands are typically littered with fallen trees, mostly shore pine from earlier seral stages.

Succession. Late seral to climax. The shore pine-Sitka spruce/evergreen huckleberry, Douglas fir/western rhododendron-evergreen huckleberry, and Port Orford cedar/evergreen huckleberry associations would be antecedent to this type.

Distribution and history. This association is common along the coast between northern California and British Columbia. On the Recreation Area, good examples can be seen on most of the larger tree islands in the dune sheet.

Management. Most stands of this association are remote and impenetrable to casual visitors. It is favored habitat for black bear. Considerable off-road vehicle damage has occurred on several more accessible tree islands, where such activity can rejuvenate sand movement and erode tree islands.

Other studies. Byrd (1950), Kumler (1963, 1969), and Kunze (1983, 1985) described similar forest associations on dunes dominated by Sitka spruce. These had shrubby understories dominated by evergreen huckleberry, salal, wax myrtle and western rhododendron. Fong (1996) described a Sitka

spruce/salal-evergreen huckleberry association from southwestern Oregon, but the species composition differs significantly from our Sitka spruce/evergreen huckleberry association, and the shrub layer is much less dense.

Common plants of the Sitka spruce/evergreen huckleberry association (n = 14 recon plots).

	Const.	Ave. cov. (%)	Range cov. (%)
OVERSTORY TREES			
Sitka spruce	100	50	15-85
Douglas fir	43	5	0-25
Shore pine	36	2	0-5
Western red cedar	21	4	0-50
Western hemlock	21	1	0-10
UNDERSTORY TREES			
Sitka spruce	57	1	0-5
Cascara	29	3	0-20
Western hemlock	21	1	0-5
Shore pine	21	Tr	0-2
Douglas fir	14	Tr	0-1
SHRUBS AND WOODY GROUNDCOVER			
Evergreen huckleberry	100	54	5-85
Salal	100	26	3-65
Wax myrtle	64	8	0-35
Western rhododendron	43	3	0-25
Silk tassel	36	4	0-15
Trailing blackberry	35	Tr	0-1
Black twinberry	29	1	0-4
HERBS, FERNS AND GRAMINOIDS			
Bracken fern	79	1	0-5
False lily-of-the-valley	64	1	0-5
Sword fern	21	Tr	0-2

DOUGLAS FIR GIANT FOREST ALLIANCE

PSME/RHMA3-VAOV2

DOUGLAS FIR/WESTERN RHODODENDRON-EVERGREEN HUCKLEBERRY FOREST

Pseudotsuga menziesii/Rhododendron macrophyllum-Vaccinium ovatum



PSME/RHMA3-VAOV2
(Sampled: 11 recon plots)
CDS301

Environment. This association occurs on dry ridges, upper slopes and tree islands throughout the dune sheet. Most aspects and slopes are represented. Soil has little organic matter, ranging from one to seven inches, averaging five inches.

Vegetation and ecology. The canopy is dominated by Douglas fir, with some Sitka spruce and a senescing component of shore pine. Western hemlock is absent. Canopies are open, ranging from 35-80 percent cover, averaging 65 percent. Conifer reproduction is almost nonexistent, and stands are littered with fallen logs, mostly shore pine. The shrub layer, dominated by evergreen huckleberry, salal and western rhododendron, is enormous and nearly impenetrable, ranging from 85-97 percent cover, averaging 94 percent. Shrub height ranges from 8-15 feet, averaging 11 feet. Some species present here, such as ocean spray, red huckleberry and western rattlesnake-plantain, are uncommon in other dune associations. Because of the dense shrub cover, a ground layer is virtually absent.

Succession. Mid seral. This association is preceded by the shore pine-Douglas fir/wax myrtle-evergreen huckleberry association. Given the lack of western hemlock, it is probably replaced by the climax Sitka spruce/evergreen huckleberry association.

Distribution and history. This association is common along the coast between northern California and Tillamook Bay, Oregon. On the Recreation Area, it occurs on most of the larger tree islands, and along the eastern edge of the dune sheet.

Management. Most stands of this association are remote and impenetrable to casual visitors. It is a favored habitat for black bear. Considerable off-road vehicle damage has occurred on several more

accessible tree islands, where machines have opened a path through the shrub layer. Such activity can rejuvenate sand movement and erode tree islands.

Other studies. Wiedemann (1984, 1990, 1993) described a Douglas fir/western rhododendron association as a climax type on dry soils, although frequent presence of western hemlock in his plots suggest that it may have been closer to our concept of the western hemlock/western rhododendron-evergreen huckleberry association.

Common plants of the Douglas fir/western rhododendron-evergreen huckleberry association (n = 11 recon plots).

	Const.	Ave. cov. (%)	Range cov. (%)
OVERSTORY TREES			
Douglas fir	100	60	30-80
Shore pine	73	3	0-10
Sitka spruce	36	3	0-10
Western red cedar	18	3	0-25
UNDERSTORY TREES			
Cascara	45	1	0-5
Douglas fir	36	1	0-2
Sitka spruce	9	Tr	0-3
Western red cedar	9	Tr	0-2
Shore pine	9	Tr	0-2
SHRUBS AND WOODY GROUNDCOVER			
Evergreen huckleberry	100	67	40-95
Salal	100	14	1-35
Western rhododendron	91	41	0-75
Wax myrtle	82	6	0-30
Ocean spray	36	2	0-10
Silk tassel	36	1	0-5
Rev huckleberry	9	Tr	0-5
Trailing blackberry	9	Tr	0-2
HERBS, FERNS AND GRAMINOIDS			
Bracken fern	64	1	0-2
Sword fern	45	1	0-2
Gnome plant	27	Tr	0-1
Ground-cone	18	Tr	0-1
Western rattlesnake-plantain	9	Tr	0-1

WESTERN HEMLOCK GIANT FOREST ALLIANCE

TSHE/RHMA3-VAOV2

WESTERN HEMLOCK/WESTERN RHODODENDRON-EVERGREEN HUCKLEBERRY FOREST

Tsuga heterophylla/Rhododendron macrophyllum-Vaccinium ovatum



TSHE/RHMA3-VAOV2
(Sampled: 16 recon plots)
CHS324

Environment. Stands occur along the landward edge of the dune sheet, where dunes have been stabilized for several hundred years and are remote from salt spray. In all cases, stands are contiguous with forest extending inland into the Coast Range. Mid to lower slopes and interdunal valleys are the most common locations, with all aspects represented. The association does not occur on tree islands, or in areas with more recent sand movement. The litter and humus layer varies from 1-6 inches deep, averaging 4 inches.

Vegetation and ecology. The canopy is dominated by western hemlock, Douglas fir or both. Douglas fir may be entirely absent, but hemlock is always present with at least 5 percent cover. The canopy is moderately dense, with cover ranging from 30-95 percent, averaging 73 percent. Basal area is the third largest recorded on the Recreation Area, averaging 125 ft² per acre. Douglas fir up to 337 years old, and Sitka spruce up to 633 years old, both obviously suppressed in the last 150 years, were recorded from this association. Hemlock in the same plots ranged from 140-170 years old. Old-growth trees have broken tops and gnarly horizontal limbs, supporting large mats of Scouler's polypody and the moss *Antitrichia curtipendula*. Conifer reproduction is sparse. The shrub layer is dominated by evergreen huckleberry, western rhododendron and salal, with cover ranging from 25-95 percent, averaging 83 percent. Shrub height averages nine feet. The herb layer is sparse.

Succession. Late seral to climax. Remote from salt spray, and depending on latitude, this association is preceded by either the Port Orford cedar/evergreen huckleberry association, or the Douglas fir/western rhododendron-evergreen huckleberry association.

Distribution and history. This association occurs along the coast between northern California and Tillamook Bay, Oregon. On the Recreation Area, the best examples seen occur west of Tahkenitch Campground, and south and west of Loon Lake.

Management. Old-growth stands have a canopy structure seemingly ideal as nesting habitat for marbled murrelets. Stands of this type are exceedingly rare along the coast, and the only example we saw on the Recreation Area was near Loon Lake. It is a remnant of an 80-acre stand of old-growth forest, half of which was clearcut in the 1960's (Pinto et al. 1972). This remnant needs to be protected.

Other studies. Kumler (1963, 1969) and Wiedemann (1984, 1990, 1993) described a similar forest type with western hemlock, Sitka spruce, western rhododendron, evergreen huckleberry and salal. Wiedemann's concept of a Douglas fir/western rhododendron climax association on dry dunes may fit here, because western hemlock was frequently present. Quayle's (1982) western hemlock/salal/sword fern association appears to be somewhat similar, but lacks rhododendron, has less salal and evergreen huckleberry, and has nearly 40 percent cover of sword fern. White (1996) described a western hemlock-tanoak/evergreen huckleberry-western rhododendron association from southwestern Oregon, but species composition differs significantly from stands sampled on the Recreation Area.

Common plants of the western hemlock/western rhododendron-evergreen huckleberry association (n = 16 recon plots).

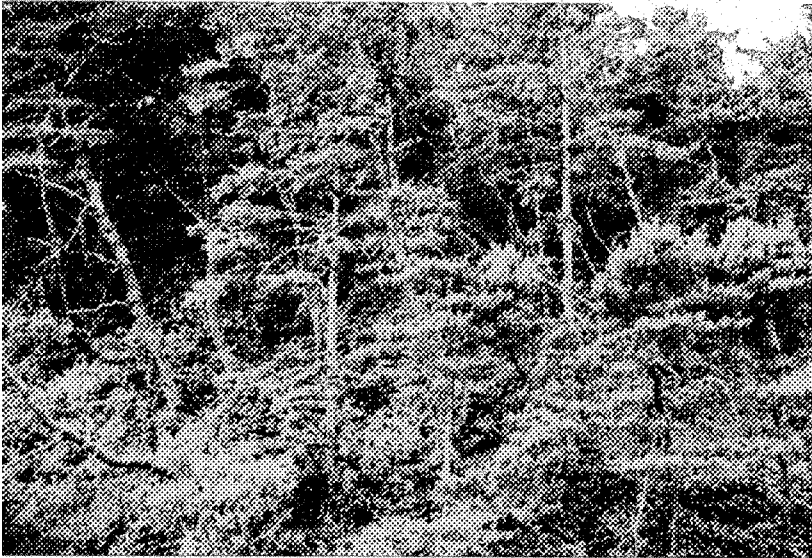
	Const.	Ave. cov. (%)	Range cov. (%)
OVERSTORY TREES			
Western hemlock	100	28	4-85
Douglas fir	88	34	0-80
Sitka spruce	63	11	0-70
Western red cedar	44	10	0-45
Shore pine	13	Tr	0-3
UNDERSTORY TREES			
Cascara	56	2	0-10
Western hemlock	56	1	0-5
Douglas fir	19	1	0-5
Western red cedar	19	Tr	0-3
SHRUBS AND WOODY GROUNDCOVER			
Evergreen huckleberry	100	52	20-80
Western rhododendron	100	39	5-70
Salal	100	22	5-75
Red huckleberry	56	1	0-5
Ocean spray	38	1	0-4
Wax myrtle	31	2	0-10
HERBS, FERNS AND GRAMINOIDS			
Bracken fern	69	1	0-3
Sword fern	38	1	0-3
Scouler's polypody	31	1	0-3
False lily-of-the-valley	25	1	0-15
Ground-cone	25	Tr	0-1

SHORE PINE FOREST ALLIANCE

PICOC-PISI/VAOV2
PICOC-PSME/MYCA-VAOV2
PICOC/CYSC4/AMAR4

SHORE PINE-SITKA SPRUCE-/EVERGREEN HUCKLEBERRY FOREST

Pinus contorta var. *contorta*-*Picea sitchensis*/*Vaccinium ovatum*



PICOC-PISI/VAOV2
(Sampled: 12 recon plots)
CLC601

Environment. This association is widespread on the Recreation Area, occurring on dry stabilized dunes, tree islands and deflation plains. Most aspects and slopes are represented. A poorly-developed humus layer from one to six inches deep overlies sand.

Vegetation and ecology. Stands are dominated by shore pine and Sitka spruce, with smaller amounts of Douglas fir. Young stands on deflation plains may be composed of low, nearly impenetrable, wind-runed thickets subject to salt spray and sand abrasion. Shore pine and Sitka spruce are the dominant reproducing conifers. Older stands may be littered with fallen trees, mostly shore pine. The shrub layer is generally dense, dominated by evergreen huckleberry, salal and wax myrtle, with up to 95 percent cover. Shrub height averages eight feet and can be up to 12 feet. The ground layer is depauperate because of the high shrub cover, but mosses are moderately abundant.

Succession. Mid seral. This association appears to replace the red fescue-salt rush, shore pine/slough edge, bog blueberry/tufted hairgrass, and the shore pine/Scots broom/European beachgrass associations. Current growth of Sitka spruce and western hemlock (Table 4) indicate that they will eventually replace Douglas fir and shore pine. Hemlock will be successful only in areas sheltered from salt spray.

Distribution and history. This association is common along the coast between northern California and southwestern Washington. It reaches its southern limit on the North Spit of Humboldt Bay, California (Pickart 1987, Duebendorfer 1992). On the Recreation Area, stands can be seen anywhere a moderate amount of shore pine and Sitka spruce have developed. Dense young stands can be seen on deflation plains north and south of Tenmile Creek.

Management. In most cases, dense vegetation excludes human intrusion. The extent of stands on deflation plains are increasing as herbaceous associations are replaced during succession. A few stands on dunes are subject to entry by recreational vehicles, with hazard of subsequent wind erosion.

Other studies. Kumler (1963, 1969) described a shore pine-Sitka spruce-shrub association as one of the forest types occurring on coastal dunes. Wiedemann (1984, 1993) described a salal-evergreen huckleberry association with tree seedlings occurring on sand plains, slopes and ridges. Pickart (1990) included this type in a broader concept of "coniferous forest." Duebendorfer (1992) described his association clearly, noting the impenetrable and wind-pruned characteristics of stands near beaches. The beach pine series of Sawyer and Keeler-Wolf (1995) includes this association.

Common plants of the shore pine-Sitka spruce/evergreen huckleberry association (n = 12 recon plots).

	Const.	Ave. cov. (%)	Range cov. (%)
OVERSTORY TREES			
Sitka spruce	83	25	0-65
Shore pine	83	24	0-65
Douglas fir	25	2	0-20
UNDERSTORY TREES			
Sitka spruce	58	5	0-30
Shore pine	42	13	0-70
SHRUBS AND WOODY GROUNDCOVER			
Evergreen huckleberry	100	32	2-80
Salal	100	25	5-40
Wax myrtle	83	17	0-40
Bearberry	33	2	0-25
Western rhododendron	17	2	0-15
Silk tassel	17	1	0-5
HERBS, FERNS AND GRAMINOIDS			
Bracken fern	42	1	0-5
False lily-of-the-valley	33	Tr	0-2

SHORE PINE-DOUGLAS FIR/WAX MYRTLE-EVERGREEN HUCKLEBERRY FOREST

Pinus contorta var. *contorta*-*Pseudotsuga menziesii*/*Myrica californica*-*Vaccinium ovatum*



PICOC-PSME/MYCA-VAOV2

(Sampled: 15 recon plots)

CLC201

Environment. This association is widespread on warm, dry ridges and slopes on the dunes, primarily with south to west-facing aspects. The poorly-developed humus layer is rarely more than one inch thick on slopes, but where organic material accumulates at the toe of slopes the layer may be up to nine inches deep.

Vegetation and ecology. Stands are dominated by shore pine and Douglas fir, with low incidence of Sitka spruce and western hemlock. Madrone is also present on ridges and toe slopes. Total canopy cover ranges from 40-85 percent. Live basal area is one of the lowest of the native forest stands occurring on the Recreation Area. Conifer reproduction is sparse or nonexistent. Stands are typically littered with fallen trees, mostly shore pine. The shrub layer, dominated by the ubiquitous evergreen huckleberry and salal, ranges from 5-95 percent, with an average height of 8 feet. The lowest shrub cover appears to be on dry, warm exposures, where bracken fern may be conspicuous. The ground layer is otherwise sparse to nonexistent. Charcoal is present in some stands.

Succession. Mid seral. Stands appear to derive from the shore pine/hairy manzanita association, and the shore pine/Scots broom/European beachgrass association. In this association, western hemlock and Sitka spruce have the greatest current growth, followed by Douglas fir (Table 4). Douglas fir will replace shore pine, and will in turn will be replaced by either Sitka spruce or western hemlock. Hemlock will succeed only in areas sheltered from salt spray.

Distribution and history. This association is common along the coast between northern California and Tillamook Bay, Oregon. Douglas fir becomes increasingly scarce on dunes farther north, where it is replaced by Sitka spruce. On the Recreation Area, stands of this association occur along the forested edge of the dune sheet, and are also the most common type on tree islands with southern to western exposure. Good examples may be seen south of Siltcoos River, and both north and south of Threemile Road.

Management. In most cases, dense vegetation or remoteness excludes human intrusion. A few stands on dunes are subject to entry by recreational vehicles, with hazard of subsequent wind erosion.

Other studies. Wiedemann (1984, 1990, 1993) described a shore pine/western rhododendron association containing Douglas fir in both overstory and understory, which may be closer to our concept of the Douglas fir/western rhododendron-evergreen huckleberry association. Pickart (1990) included this type in a broader concept of "coniferous forest." The beach pine series of Sawyer and Keeler-Wolf (1995) includes this association.

Common plants of the shore pine-Douglas fir/wax myrtle-evergreen huckleberry association (n = 15 recon plots).

	Const.	Ave. cov. (%)	Range cov. (%)
OVERSTORY TREES			
Shore pine	100	43	30-60
Douglas fir	100	22	5-45
Sitka spruce	33	1	0-5
Western hemlock	20	1	0-10
UNDERSTORY TREES			
Douglas fir	33	1	0-5
Sitka spruce	33	1	0-5
Shore pine	33	1	0-3
Western hemlock	33	Tr	0-2
SHRUBS AND WOODY GROUNDCOVER			
Evergreen huckleberry	100	52	5-90
Salal	100	21	2-70
Western rhododendron	80	22	0-60
Wax myrtle	73	7	0-30
Scots broom	60	1	0-2
Bearberry	40	Tr	0-2
Hairy manzanita	33	1	0-5
HERBS, FERNS AND GRAMINOIDS			
Bracken fern	93	4	0-20
Ground-cone	40	Tr	0-2
False lily-of-the-valley	20	Tr	0-4
Candystick	20	Tr	0-1

SHORE PINE/SCOTS BROOM/EUROPEAN BEACHGRASS FOREST

Pinus contorta var. *contorta*/*Cystisus scoparius*/*Ammophila arenaria*



PICOC/CYSC4/AMAR4
(Sampled: 14 recon plots)
CLS832

Environment. This weedy association occurs on dry sand, on all aspects and slopes, between deflation plains and the forest edge. The substrate is sand.

Vegetation and ecology. Many stands of this association were planted for dune stabilization between 1935 and 1970, but naturally-occurring stands with the same composition are also common on the Recreation Area. Although we sampled only 30-50 year-old stands, we have lumped here younger shrubland stands as well, all characterized by presence of Scots broom, usually with a weedy understory dominated by European beachgrass and many other species. Scots pine and black pine, both exotic species, were sometimes planted instead of shore pine, and Sitka spruce is often codominant. In stands with less than 25 percent tree cover, Scot's broom may reach densities of 90 percent cover and heights of 10 feet, after which entire stands begin to senesce. The understory is a mix of European beachgrass, little hairgrass, false dandelion, silver hairgrass, bracken, sheep sorrel and other Eurasian weeds. Dense stands of Scot's broom may have high cover of moss in the ground layer. In stands with tree cover greater than 25 percent, Scots broom and European beachgrass become less abundant. Moss cover is low in woodland stands because of diminished shade under Scot's broom, but in stands with a closed tree canopy, the ground layer becomes dominated by mosses, especially *Eurhynchium oreganum*, with up to 95 percent cover. In these more mature stands, relictual Scots broom and European beachgrass may persist in openings. Around the mouth of the Columbia River, this association may contain American beachgrass (*Ammophila breviligulata*), native to the east coast of North America. This species has not been reported from the Recreation Area.

Succession. Early to mid seral. Unless they were planted, stands develop from either the European beachgrass association or the tree lupine/European beachgrass association. The seral status of the association is confirmed by the virtual lack of dead trees (Fig. 10). Douglas fir had the greatest current growth (Table 4), indicating that Douglas fir will eventually replace the shore pine. Depending on exposure to wind and salt spray, stands are replaced by either the shore pine-Douglas fir/wax myrtle-evergreen huckleberry association, or the shore pine-Sitka spruce/evergreen huckleberry association.

Distribution and history. This association occurs along the coast between northern California and southwestern Washington. On the Recreation Area, mature plantations with closed canopies can be seen north of Siltcoos River. Younger stands with open canopies can be seen near Cleawox Lake, south of Siltcoos River, and south of Tenmile Creek. McLaughlin and Brown (1942) and Pinto et al. (1972) described protocol for dune stabilization work that called for planting European beachgrass with a nitrogen-fixing species such as Scots broom, followed a year or two later by shore pine. Such plantings develop into the shore pine/Scots broom/European beachgrass association.

Management. Plantations 30-50 years old with closed canopies are good areas for collecting matsutake mushrooms. Motorized recreation here should be restricted to trails, in order to maintain mushroom-picking opportunities. Open stands with dense populations of Scots broom serve as seed sources for this invasive species. Scots broom could be eliminated by repeated burning, pulling, and several years of subsequent monitoring, with additional pulling as required.

Other studies. The broom series of Sawyer and Keeler-Wolf (1995) includes elements of this association.

Common plants of the shore pine/Scots broom/European beachgrass association (n = 14 recon plots).

	Const.	Ave. cov. (%)	Range cov. (%)
OVERSTORY TREES			
Shore pine	71	25	0-80
Sitka spruce	43	1	0-10
Douglas fir	7	Tr	0-5
UNDERSTORY TREES			
Shore pine	71	4	0-20
Sitka spruce	64	5	0-20
Douglas fir	14	Tr	0-1
SHRUBS AND WOODY GROUND COVER			
Scots broom	100	36	1-90
Evergreen huckleberry	50	4	0-35
Salal	29	1	0-8
Chaparral broom	21	Tr	0-1
Wax myrtle	14	2	0-15
HERBS, FERNS AND GRAMINOIDS			
European beachgrass	100	36	1-95
Little hairgrass	71	11	0-85
False dandelion	71	1	0-3
Sword fern	64	1	0-1
Silver hairgrass	43	5	0-45
Licorice fern	43	Tr	0-1

SHORE PINE/SLOUGH SEDGE SEASONALLY FLOODED FOREST

Pinus contorta var. *contorta*/*Carex obnupta*



PICOC/CAOB3
(Sampled: 6 recon plots)
CLM101

Environment. This wetland association occurs in depressions on deflation plains and on ancient marine terraces. A high water table in winter, or impeded drainage from iron-cemented hardpan, precludes invasion by upland species of shrubs and trees. The depressions fill with one to three feet of standing water in winter and early spring, but dry up by early summer. Sand in dried-up depressions may be stained with iron. Peat does not develop at these sites because summer drying oxidizes any organic material.

Vegetation and ecology. These stands are dominated by shore pines up to 130 years old, but most range from 30-75 years. Canopy cover between 70-85 percent, and shore pine is the only reproducing conifer present. The sparse shrub layer, ranging from 1-25 percent cover, contains wax myrtle, salal and evergreen huckleberry, growing on mounds in and around the depressions. Slough sedge dominates the ground layer, with density varying inversely with depth and duration of winter flooding. Moss cover ranges from 2-95 percent cover, with drought-tolerant *Warnstorfia exannulata*, *Fontinalis howellii*, *Sphagnum mendocinum* and *Polytrichum commune* being most conspicuous. Live basal area is one of the lowest of any forest association in the Recreation Area (Fig. 10). Inclusions of the Hooker's willow-crabapple/slough sedge association may occur in deeper depressions where water persists later in the season. The seasonally high water table inhibits invasion of upland species, and this association persists long after surrounding vegetation has developed into upland forest. Long-term infilling by organic material causes transition to upland vegetation. Pumping of groundwater for municipal use may be causing the water table to drop in some areas of the Recreation Area, and may hasten invasion of upland species.

Succession. Early to mid seral. This association replaces the Hooker willow/slough sedge-Pacific silverweed association, and possibly the bog blueberry/slough sedge association, although we saw no evidence of the latter. The seral status of the association is confirmed by the virtual lack of dead trees

in most stands (Fig. 10). It may be replaced by the shore pine/Labrador tea association, and eventually by the shore pine-Sitka spruce/evergreen huckleberry association, as seen on Goose Pasture.

Distribution and history. This association occurs sporadically along the coast between northern California and southwestern Washington, with most known occurrences concentrated between the Siuslaw River and Heceta Head. Old-growth stands are rare. Some stands are developing on deflation plains as an artifact of the expansion of this landform after the advent of European beachgrass. Individual stands rarely exceed 10 acres in size. On the Recreation Area, the best-developed old-growth sites occur near Horsfall Lake.

Management. Some of these sites are favored for picking chanterelle mushrooms. After the standing water dries up in early to mid-summer, stands are vulnerable to damage from off-road vehicles. Privately-owned stands in the Florence area are being destroyed by residential and commercial development. Management should include identification, protection and monitoring of old-growth stands, and monitoring of younger stands on deflation plains to see if they are developing into the same association. Groundwater pumping in the vicinity of Horsfall Lake and Beale Lake needs to be monitored to determine if it is detrimental to the plant associations there.

Other studies. Egler (1934), Wiedemann (1966, 1984, 1993), Wiedemann et al. (1969) and Christy (1979) described this association clearly. The beach pine series of Sawyer and Keeler-Wolf (1995) include this association.

Common plants of the shore pine/slough sedge association (n = 6 recon plots).

	Const.	Ave. cov. (%)	Range cov. (%)
OVERSTORY TREES			
Shore pine	100	63	40-85
UNDERSTORY TREES			
Shore pine	50	1	0-3
SHRUBS AND WOODY GROUNDCOVER			
Evergreen huckleberry	100	6	1-15
Wax myrtle	83	9	0-20
Salal	67	2	0-5
Hooker willow	50	5	0-12
Bog blueberry	50	2	0-8
Black twinberry	50	1	0-1
HERBS, FERNS AND GRAMINOIDS			
Slough sedge	100	48	25-75
Pacific silverweed	33	4	0-20
Tufted hairgrass	33	3	0-15
Northern bugleweed	33	2	0-8

SITKA SPRUCE SATURATED FOREST ALLIANCE

PISI-ALRU/CAOB3-LYAM3

SITKA SPRUCE-RED ALDER/SLOUGH SEDGE-SKUNK CABBAGE SATURATED FOREST

Picea sitchensis-*Alnus rubra*/*Carex obnupta*-*Lysichiton americanum*



PISI-ALRU/CAOB3-LYAM3

(Not sampled)

CSH401

Environment. Small examples of this association were seen on the Recreation Area, but never sampled quantitatively. It occurs in depressions between old stabilized dunes, and on floodplains adjacent to perennial streams. Soils are perennially wet, usually with high organic content.

Vegetation and ecology. Stands of this type are dominated by Sitka spruce, with cover ranging from 0 to 85 percent. Red alder may cover 10 to 50 percent of the plot, with lesser amounts of western hemlock and western red cedar occurring on root mounds and decaying logs. While spruce may reach large diameters typical of those growing in upland sites, growth rates in perennially wet soils are slow, and ages of trees often greatly exceed estimates based on familiarity with upland stands. Shallow root systems, buttressed roots, yellowing needles, a reduced branching pattern, thick boles tapering rapidly toward the crown, and reduced crown spread are typical of swamp spruce. Large wads of Scouler's alder, and thick mats of epiphytic mosses, particularly *Antitrichia curtipendula*, are typical on upper trunks and limbs. In stands with lower canopy cover, high light levels may favor a dense growth of red alder, crabapple, black twinberry, salmonberry and Hooker willow, with salal, evergreen huckleberry, and vine maple occurring on root mounds and decaying stumps and logs. The herb layer is a mix of slough sedge, skunk cabbage, water-parsley, and lady fern, with sword fern and false lily-of-the-valley occurring on root mounds. Bare exposures of often deep, mucky soil often occur among the sedge. Windthrow is frequent, creating gaps for spruce regeneration, often as resprouts from fallen boles. Because of logging, old-growth examples of this association are rare.

Succession. Late seral to climax. Stands of this type replace both the red alder/salmonberry/slough sedge-skunk cabbage association and the Hooker willow-crabapple/slough sedge-skunk cabbage association. They appear to be climax, and spruce may reach ages of 300 years or more.

Distribution and history. This association occurs along the coast from southwestern Oregon to Washington. Old-growth stands are rare, because most swamps were readily accessible for logging, and suitable sites were never numerous or extensive. This association is rare on the Recreation Area, as there are few floodplains or sites with perennially wet, organic soils. Small examples were seen along Eel Creek and Siltcoos River. Other known sites include Cape Blanco State Park, Cape Lookout State Park, near the Waldport Job Corps site, and at Blind Slough Preserve on the lower Columbia River.

Management. Remnant old-growth stands of this association may contain considerable volumes of timber, but should be protected because this association is so rare. Large horizontal limbs and their moss mats may provide nesting sites for marbled murrelets. Because of shallow rooting in waterlogged soils, sites are vulnerable to catastrophic windthrow, and windfirm buffers may help avert damage in some cases. Some sites are also vulnerable to tsunamis or drowning caused by subsidence following an earthquake. The exotic English ivy is invading many stands, where it roots on elevated bases of trees, and may form dense stands in the upper canopy.

Other studies. The Sitka spruce/devils club/skunk cabbage, Sitka spruce/blueberry/skunk cabbage, mixed conifer/salal/skunk cabbage, and mixed conifer/blueberry/skunk cabbage associations of DeMeo et al. (1992), Shepard (1995), Martin et al. (1995) and Boggs (1998) have site characteristics similar to those of this association, but they differ floristically. Kunze (1994) described a Sitka spruce-red alder/salmonberry/slough sedge association and a Sitka spruce-red alder/skunk cabbage association that are similar to this type. Her sites typify “tidewater” spruce swamps occurring along low-gradient coastal rivers, where stands are regularly irrigated or subirrigated with freshwater tidal flooding.

RED ALDER SATURATED FOREST ALLIANCE

ALRU/RUSP/CAOB3-LYAM3

RED ALDER/SALMONBERRY/SLOUGH SEDGE-SKUNK CABBAGE SATURATED FOREST

Alnus rubra/*Rubus spectabilis*/*Carex obnupta*-*Lysichiton americanum*



ALRU/RUSP/CAOB3-LYAM3

(Sampled: 2 recon plots)

HAM101

Environment. The red alder/salmonberry/slough sedge-skunk cabbage association is poorly represented in the Recreation Area because of the dearth of streams and floodplains. It occurs on perennially saturated stream terraces within the forest zone of the Recreation Area, east of the dune sheet. These streams are small, and confined to relatively narrow valleys. Terraces are rarely broader than 50 feet. Substrate is sand, silt or peat on a floodplain that may be inundated during brief periods of high runoff after winter storms.

Vegetation and ecology. Stands are dominated by red alder between 20-50 years old, with canopy cover ranging from 65-85 percent. Sitka spruce, though sparse, is the major conifer in the canopy and understory. The scanty shrub layer is dominated by black twinberry and salmonberry. The ground layer is dominated by slough sedge 1-3 feet tall, with 70-85 percent cover. Floods that rework floodplain sediments and destroy vegetation are probably the major disturbance factor.

Succession. Mid seral. Stands of this type may be preceded by the slough sedge association. Henderson (1979) projected that stands lacking regeneration of alder deteriorate after about 150 years. Presence of Sitka spruce, with its ability to grow in perennially wet soils, suggests that these stands develop into the Sitka spruce-red alder/slough sedge-skunk cabbage association.

Distribution and history. This association is common along the coast between northern California and British Columbia. In the Recreation Area, early logging on uplands no doubt increased runoff and sediment loads, diminished the amount of woody debris in the stream channel, and changed the configuration and composition of stream terraces. Small examples of this association can be seen along the Threemile Creek road and along Tenmile Creek at Spinreel Campground.

Management. Road construction and debris torrents are the main threat to these associations. Good watershed management will reduce flood hazard, and placement of roads on uplands rather than stream terraces will reduce losses. Roads on stream terraces could be removed in some places.

Other studies. Henderson (1970, 1979) described a red alder/salmonberry associates along the Alsea River in Oregon's Coast Range, inland from the Sitka spruce zone. Stands on the Recreation Area appear to be wetter than those sampled by Henderson, and the shrub and ground layers are very different. Duebendorfer (1992) described a "riparian deciduous forest" dominated by red alder, that may be similar to stands on the Recreation Area. The Sitka spruce-red alder association of DeMeo et al. (1992) occupies similar sites, but lacks slough sedge. Kunze (1994) described a Sitka spruce-red alder/salmonberry/slough sedge association occurring along low-gradient streams that may be similar to this association.

Common plants of the red alder/salmonberry/
slough sedge-skunk cabbage association (n = 2
recon plots).

	Const.	Ave. cov. (%)	Range cov. (%)
OVERSTORY TREES			
Red alder	100	60	40-80
Sitka spruce	50	8	0-15
Western hemlock	50	2	0-3
UNDERSTORY TREES			
Cascara	100	5	Tr-10
Sitka spruce	100	1	1
Crabapple	50	8	0-15
Western hemlock	50	1	0-1
SHRUBS AND WOODY GROUNDCOVER			
Black twinberry	100	2	1-2
Salmonberry	100	1	1
Hooker willow	50	3	0-5
Douglas spiraea	50	3	0-5
Trailing blackberry	50	1	0-1
HERBS, FERNS AND GRAMINOIDS			
Slough sedge	100	80	75-85
Sword fern	100	2	1-3
Skunk cabbage	50	2	0-4
False lily-of-the-valley	50	2	0-4

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WOODLAND ASSOCIATIONS

Shore pine/bearberry woodland (PICOC/ARUV)	68
Shore pine/hairy manzanita woodland (PICOC/ARCO3)	70



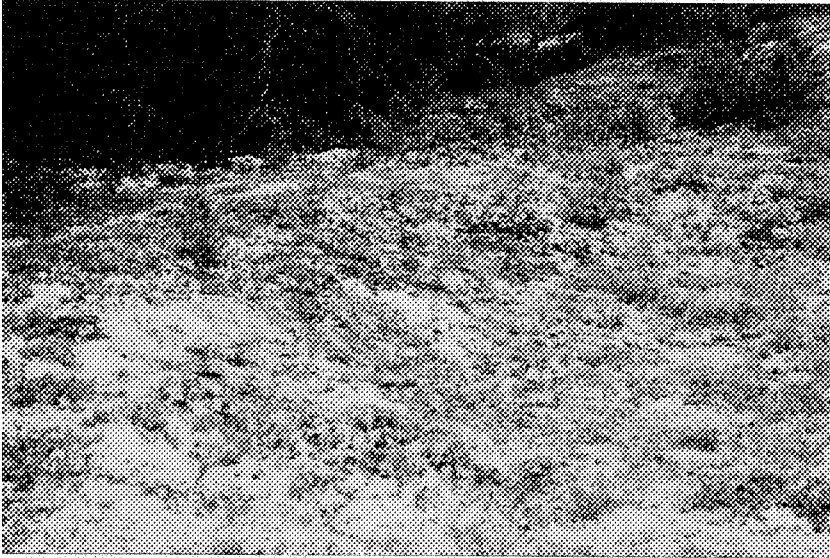
Shore pine/hairy manzanita association.

SHORE PINE WOODLAND ALLIANCE

PICOC/ARUV
PICOC/ARCO

SHORE PINE/BEARBERRY WOODLAND

Pinus contorta var. *contorta*/*Arctostaphylos uva-ursi*



PICOC/ARUV
(Sampled: 11 recon plots)
CLS301

Environment. This association occurs on all aspects on dry, partially-stabilized sand ridges, slopes, and flats, between open sand and the forest edge. Stands also occur on dry deflation plains. Requirements seem to be minimal sand movement, and well-drained, exposed sites.

Vegetation and ecology. Stands are dominated by conspicuous mats of bearberry, reindeer lichens and mosses. Common species of lichens and mosses include *Cladonia portentosa* ssp. *pacifica*, *Cladonia cervicornis* ssp. *verticillata*, *Racomitrium ericoides*, *Polytrichum juniperinum* and *Polytrichum piliferum*. These form thin, fragile mats growing over bare sand, with very little organic matter. Bearberry may cover up to 75 percent of stands, mosses up to 80 percent, and lichens up to 25 percent. These mats are closely associated with young shore pine in typically open stands, and Douglas fir and Sitka spruce are present in small amounts. The early seral status of the association is confirmed by the virtual lack of dead trees, and live basal area is the lowest of any forest association in the Recreation Area (Fig. 10). The shrub layer is sparse, and most vegetation is confined to the ground layer. Bracken fern, little hairgrass and candystick may be conspicuous. Areas of open sand often contain remnants of earlier seral stages, such as red fescue, seashore bluegrass or seashore lupine. Scots broom is invading many sites.

Succession. Early to mid seral. This association can replace either the red fescue association, or the red fescue-bracken fern association. It is in turn replaced by the shore pine/hairy manzanita association, and often contains elements of both. Remnants of this type persist in openings in the shore pine/hairy manzanita association, and in the shore pine-Douglas fir/wax myrtle-evergreen huckleberry association.

Distribution and history. This association occurs discontinuously along the coast between northern California and southwestern Washington, although Douglas fir and hairy manzanita become scarce north

of Tillamook Bay, Oregon. It occurs throughout the Recreation Area along the border between open dunes and forests. Some of the best examples can be seen around the Eel Creek Campground, and west of Hauser. This association may be declining because of dune stabilization, and possibly the absence of stand-replacing fire. Bearberry is also called kinnikinnik.

Management. The fragile mats of lichens and bearberry in this association are readily destroyed by recreational vehicles and heavy foot traffic (Wiedemann 1990, 1993; Brown 1990). Reindeer lichens (*Cladina* and *Cladonia* spp.) are the first to disappear from the plots, followed by bearberry. The lichen layer may take more than 8 years to recover (Bayfield 1979; Bayfield et al. 1981). Recreational vehicles and heavy foot traffic need to be excluded from selected areas. Invading trees may be removed by cutting. This association is favored for collecting matsutake mushrooms, but mycorrhizal relationships and impacts from harvest and trampling are unknown.

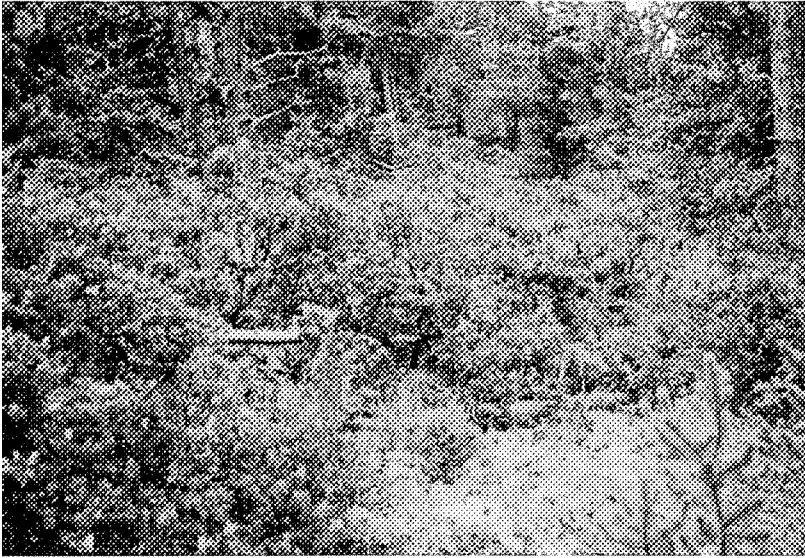
Other studies. Egler (1934) described a bearberry association that also included hairy manzanita. Kumler (1963, 1969) described a "secondary shrub intergrade" association and a "shore pine-shrub" association containing bearberry. Kunze (1983) described a mixed shrub association containing bearberry. Wiedemann (1984, 1990, 1993) described a very similar bearberry/*Racomitrium canescens* association on sheltered inactive bare sand. Pickart (1990) included this association in a broader concept of "coniferous forest." Duebendorfer (1992) described a phase of his "beach pine/Sitka spruce forest" with a sparse shrub layer, and a ground layer dominated by bearberry, *Cladina*, and other taxa.

Common plants of the shore pine/bearberry association (n = 11 recon plots).

	Const.	Ave. cov. (%)	Range cov. (%)
OVERSTORY TREES			
Shore pine	91	31	0-75
Douglas fir	9	Tr	0-3
Sitka spruce	9	Tr	0-2
UNDERSTORY TREES			
Shore pine	100	7	1-25
Douglas fir	18	Tr	0-2
Sitka spruce	18	Tr	0-1
Western hemlock	9	Tr	0-1
SHRUBS AND WOODY GROUNDCOVER			
Bearberry	100	28	3-75
Hairy manzanita	91	5	0-20
Evergreen huckleberry	91	3	0-10
Salal	91	2	0-10
Scots broom	45	4	0-15
Wax myrtle	36	1	0-5
HERBS, FERNS AND GRAMINOIDS			
Red fescue	82	1	0-5
Little hairgrass	82	1	0-1
Candystick	73	1	0-2
Seashore lupine	64	1	0-5
False dandelion	64	1	0-5
Bracken fern	36	1	0-10
Seashore bluegrass	36	1	0-5
Silver hairgrass	36	Tr	0-1

SHORE PINE/HAIRY MANZANITA WOODLAND

Pinus contorta var. *contorta*/*Arctostaphylos columbiana*



PICOC/ARCO3
(Sampled: 5 recon plots)
CLS831

Environment. The shore pine/hairy manzanita association occurs on all aspects on dry, partially-stabilized sand ridges, slopes, and flats, between open sand and the forest edge. Requirements seem to be minimal sand movement, and well-drained sites. Burial by moving sand is occurring in some areas.

Vegetation and ecology. This association is dominated by shore pine, with lesser amounts of Douglas fir, forming an open canopy with 20-55 percent cover. Pines in mature stands are between 80-130 years old. The shrub layer is dominated by hairy manzanita and evergreen huckleberry averaging 6 feet tall, with 45-95 percent cover. The ground layer is sparse, with small ericaceous plants such as pinesap and sanddrops occasional. Small openings contain remnants of the shore pine/bearberry association, with moss and reindeer lichens conspicuous, particularly *Cladonia portentosa* ssp. *pacifica*. The lichen flora in the shrub layer is diverse, with many cyanolichens, and includes several rare species such as *Leioderma soledadense* and *Leioderma soledadense*. Droughty, nutrient-poor soils and slow growth make this a long-lived association.

Succession. Early to mid seral. Stands of this type replace the shore pine/bearberry association. Douglas fir had a greater current growth than shore pine (Table 4), indicating that this association is mid-seral, and that Douglas fir will eventually replace shore pine. Depending on latitude, it is later replaced by either the Port Orford cedar/evergreen huckleberry association, or the shore pine-Douglas fir/wax myrtle-evergreen huckleberry association.

Distribution and history. This association occurs discontinuously along the coast between northern California and Tillamook Bay, Oregon. It occurs throughout the Recreation Area along the border between open dunes and forests. Typical examples can be seen around the Eel Creek Campground, and west of Hauser. It may now be in decline because of dune stabilization, and possibly the absence of sand-replacing fires.

Management. Stands are vulnerable to sand blowout that may follow fire or mechanical disturbance. Management should include protection and monitoring of several representative stands, with control of conifer invasion by cutting. This association is favored for collecting matsutake mushrooms, but

mycorrhizal relationships and impacts from harvest and trampling are unknown (Pilz et al. 1996). Because the ground layer is fragile, recreational vehicles should be excluded.

Other studies. Egler (1934) included this association in his description of the bearberry association. Kumler (1963, 1969) described a "secondary shrub intergrade" association and a "shore pine-shrub" association containing hairy manzanita. Wiedemann (1984, 1993) described this association clearly.

Common plants of the shore pine/hairy manzanita association (n = 5 recon plots).

	Const.	Ave. cov. (%)	Range cov. (%)
OVERSTORY TREES			
Shore pine	100	31	20-55
Douglas fir	40	3	0-15
UNDERSTORY TREES			
Shore pine	80	3	0-10
Douglas fir	40	1	0-3
SHRUBS AND WOODY GROUNDCOVER			
Hairy manzanita	100	39	15-65
Evergreen huckleberry	100	36	15-75
Salal	100	17	2-40
Western rhododendron	80	2	0-5
Bearberry	60	1	0-5
Wax myrtle	40	5	0-15
Scots broom	40	1	0-3
HERBS, FERNS AND GRAMINOIDS			
Bracken fern	60	1	0-3
Ground-cone	40	Tr	0-Tr
Gnome plant	20	Tr	0-Tr
Pinesap	20	Tr	0-Tr
Candystick	20	Tr	0-Tr

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SHRUBLAND ASSOCIATIONS

Tree lupine/European beachgrass shrubland (LUAR/AMAR4)	74
Hooker willow/slough sedge-Pacific silverweed shrubland (SAHO/CAOB3-AREGE)	76
Douglas spiraea shrubland (SPDO)	78
Hooker willow-crabapple/slough sedge-skunk cabbage shrubland (SAHO-MAFU/CAOB3-LYAM3)	80



The Hooker willow/slough sedge-Pacific silverweed association on an old deflation plain.

TREE LUPINE SHRUBLAND ALLIANCE

LUAR/AMAR4

TREE LUPINE/EUROPEAN BEACHGRASS SHRUBLAND

Lupinus arboreus/*Ammophila arenaria*



LUAR/AMAR4

(Sampled: 2 recon plots)

SW8101

Environment. This association is restricted to deflation plains and the landward side of foredunes. Topography is flat or hummocky. Soils are dry sand with very little organic material. Occurrences of this association are partially sheltered from salt spray and high winds by foredunes. Sand movement is limited by dense growths of European beachgrass.

Vegetation and ecology. This association is dominated by species planted for dune stabilization, or species naturalized from stabilization programs. Shore pine, Sitka spruce, and Douglas fir can be present in small amounts as seedlings or saplings. Tree lupine is the major shrub present, with cover ranging from 40-70 percent. Scots broom, another species introduced for dune stabilization programs and subsequently naturalized, can have up to 15 percent cover. The herb layer is dominated by European beachgrass with up to 70 percent cover, but 23 other species are also present, most of them weedy, introduced species, much like those in the shore pine/Scots broom/European beachgrass association. Pickart et al. (1990) found that bush lupine elevated levels of ammonium in the sand, and increased soil moisture through shading. These changes fostered invasion of exotic annual grasses and other weeds that, in turn, increased levels of organic matter and nitrate in the soil. While these are precisely the objectives of dune stabilization programs, the effects disrupt the composition and succession of native plant associations.

Succession. Early seral. If not planted, the tree lupine/European beachgrass association replaces the European beachgrass association. It is in turn replaced by the shore pine/Scots broom/European beachgrass association.

Distribution and history. It is not known how extensively tree lupine was planted along the coast north of California, but it is now scarce in both Oregon and southwestern Washington. In Oregon, most populations are now limited to the Recreation Area, where they occur on the South Jetty of the Siuslaw

River. Many of these have died in recent years, presumably because of frost. Tree lupine is also called yellow bush lupine.

Management. In northern California, 50 years of aerial photographs show that tree lupine has spread at an average rate of 6.4 acres per year (Miller 1987). Tree lupine originally was native as far north as Marin County (Davy 1902; Miller 1988) or Mendocino County (Sawyer and Keeler-Wolf 1995). More northerly populations, including those on the Recreation Area, originated from plantings for dune stabilization, ornamental purposes, and subsequent self-seeding (Miller 1988). Tree lupine may never become a management problem on the Recreation Area. It appears to be restricted to the South Jetty, and the recent die-back there may prevent further spread of the species.

Other studies. Miller (1988) described vegetation dominated by tree lupine in northern California. The "lupine scrub" of Duebendorfer (1990) and Pickart (1990) is similar to that observed on the Recreation Area. The yellow bush lupine series of Sawyer and Keeler-Wolf (1995) do not include European beachgrass.

Common plants of the tree lupine/European beachgrass association (n = 2 recon plots).

	Const.	Ave. cov. (%)	Range cov. (%)
UNDERSTORY TREES			
Shore pine	100	2	2-2
Douglas fir	50	1	0-1
SHRUBS AND WOODY GROUNDCOVER			
Tree lupine	100	55	40-70
Scots broom	50	8	0-15
Hooker willow	50	1	0-2
Black twinberry	50	1	0-2
Wax myrtle	50	1	0-2
Sitka willow	50	1	0-2
Evergreen huckleberry	50	1	0-1
Chaparral broom	50	1	0-1
HERBS, FERNS AND GRAMINOIDS			
European beachgrass	100	40	20-60
Pearly everlasting	100	4	2-5
False dandelion	100	3	2-3
Coast strawberry	100	3	2-3
Little hairgrass	100	2	2-2
Silver hairgrass	100	2	1-2
Velvet grass	100	1	1-1
Sheep sorrel	100	1	1-1
Seashore lupine	50	3	0-5
Yarrow	50	3	0-5
American dunegrass	50	3	0-5
Sword fern	50	2	0-4
Orchard-grass	50	2	0-3
Toothed Australian fireweed	50	2	0-3

HOOKER WILLOW SEASONALLY FLOODED SHRUBLAND ALLIANCE

SAHO/CAOB3-AREGE

HOOKER WILLOW/SLOUGH SEDGE-PACIFIC SILVERWEED SHRUBLAND

Salix hookeriana/*Carex obnupta*-*Argentina egedii*



SAHO/CAOB3-AREGE
(Sampled: 18 recon plots)
SW1101

Environment. This wetland association occupies extensive areas of deflation plains and in interdunal swales. The substrate is an organic layer two to 20 inches thick, underlain by sand. Stands are seasonally flooded, and may dry out in midsummer. Although stands on deflation plains may be subject to salt spray, brackish water is absent.

Vegetation and ecology. This association is dominated by shrubs, particularly Hooker willow, with lesser amounts of wax myrtle, salal and evergreen huckleberry. Around the edges, it may intergrade with other deflation plain associations that share a number of the same herbaceous species. The tree layer, when present, is composed of young shore pine and Sitka spruce. The herb layer is rich, with a total of 42 species. It is dominated by slough sedge and Pacific silverweed, ranging from 55-90 percent cover. Bare sand may range from 0-40 percent. Marsh cinquefoil becomes a common component farther north. The density of Hooker willow increases as stands age.

Succession. Early seral. This association replaces the slough sedge-Pacific silverweed, when shrub densities exceed about 20 percent. If no sand burial or drainage occurs, the shore pine/slough sedge association will develop on these sites.

Distribution and history. This association is common along the coast between northern California and British Columbia. On the Recreation Area, good examples may be seen along the South Jetty Road. Pacific silverweed has also been called *Potentilla pacifica*.

Management. Off-road vehicle use may be heavy along the margins of some stands. On the South Jetty, some areas have been destroyed by creation of wetlands for waterfowl production.

Other studies. Kunze (1983, 1985) described deflation plain associations dominated by Hooker willow, and Wiedemann (1984, 1990, 1993) described a Hooker willow-wax myrtle association that would fit our concept of the Hooker willow/slough sedge-Pacific silverweed association on the Recreation Area. The "woody hollow" association of Duebendorfer (1990, 1992), and the "deciduous swamp" association of Pickart (1990) and Duebendorfer (1992) are similar to our concept of the Hooker willow/slough sedge-Pacific silverweed association. Kunze (1994) described a Hooker willow/slough sedge association from deflation plains in Washington, but did not include Pacific silverweed. The Hooker willow series of Sawyer and Keeler-Wolf (1995) includes this association, while that of Shephard (1995) and Boggs (1998) are quite different floristically.

Common plants of the Hooker willow/slough sedge-Pacific silverweed association (n = 18 recon plots).

	Const.	Ave. cov. (%)	Range cov. (%)
OVERSTORY TREES			
Shore pine	28	3	0-30
Sitka spruce	22	1	0-10
UNDERSTORY TREES			
Shore pine	33	2	0-35
Sitka spruce	17	Tr	0-2
Western red cedar	6	Tr	0-1
SHRUBS AND WOODY GROUNDCOVER			
Hooker willow	100	42	20-60
Wax myrtle	39	7	0-40
Salal	39	3	0-15
Evergreen huckleberry	28	1	0-5
HERBS, FERNS AND GRAMINOIDS			
Slough sedge	100	50	10-80
Pacific silverweed	94	23	0-80
Marsh speedwell	67	1	0-5
Bird-foot trefoil	61	5	0-30
Salt rush	50	2	0-10
Creeping buttercup	50	1	0-4

DOUGLAS SPIRAEA SATURATED SHRUBLAND ALLIANCE

SPDO

DOUGLAS SPIRAEA SATURATED SHRUBLAND

Spiraea douglasii



SPDO

(Sampled: 1 recon plot)

SW4114

Environment. This wetland association occurs on perennially-wet organic muck and fibrous peat adjacent to lakes and ponds, and on old deflation plains. Peaty muck forms under anaerobic conditions in basins with impeded drainage. Sites may be flooded seasonally or year-round, or subirrigated in summer. Water levels must be relatively constant to maintain hydrology. Dune-blocked lakes formed at the edge of the dune sheet are the most common sites. Gently-sloping, shallow lakeshores are necessary for formation of this association.

Vegetation and ecology. Stands are nearly monotypic, dominated by Douglas spiraea with lesser amounts of Hooker willow. A tree layer is absent. Total shrub cover in the single recon plot sampled was 60 percent, and shrub height averaged 5 feet. The sparse herb layer is dominated by slough sedge, nitka sedge and lady fern. Inclusions of other wetland species such as hardstem bulrush or pond lily are frequently remnants of earlier seral associations. Toothed Australian fireweed, frequently present on elevated hummocks in coastal wetlands, can increase dramatically when stands are drained. Changes in hydrology may cause Douglas spiraea to increase in density. More northerly examples may contain sweet gale (*Myrica gale*) and Labrador tea.

Succession. Early seral. This association is intermediate between herbaceous wetland associations, and those dominated by tall shrubs or trees. It replaces the simplestem bur-reed, hardstem bulrush, slough sedge and inflated sedge associations. It is in turn replaced by the Hooker willow-crabapple/slough sedge-skunk cabbage association.

Distribution and history. This association is common along the coast between northern California and southeastern Alaska. Stands of Douglas spiraea occurring in interior valleys have not been sampled. In the Recreation Area, examples may be seen in dune hollows in the Horsfall area, and at the northern end of Threemile Lake.

Management. Wet soils and shrub density preclude any recreational use in this association.

Other studies. Thomas (1980) and Wiedemann (1984) and Kunze (1994) described coastal associations dominated by Douglas spiraea.

Common plants of the Douglas spiraea association
(n = 1 recon plot).

	Const.	Ave. cov. (%)	Range cov. (%)
SHRUBS AND WOODY GROUNDCOVER			
Douglas spiraea	100	60	60
Hooker willow	100	2	2
HERBS, FERNS AND GRAMINOIDS			
Slough sedge	100	20	20
Toothed Australian fireweed	100	10	10
Hardstem bulrush	100	3	3
Lady fern	100	2	2

HOOKER WILLOW SATURATED SHRUBLAND ALLIANCE

SAHO-MAFU/CAOB3-LYAM3

HOOKER WILLOW-CRABAPPLE/SLOUGH SEDGE-SKUNK CABBAGE SATURATED SHRUBLAND

Salix hookeriana-Malus fusca/Carex obnupta-Lysichiton americanum



SAHO-MAFU/CAOB3-LYAM3

(Sampled: 2 recon plots)

SW1102

Environment. This association occurs on perennially wet mucky soils with high organic content. It usually occurs adjacent to lakes and ponds, and on old deflation plains. Sites may be flooded seasonally or year-round, but water is usually just below the ground surface in summer. Water levels must be relatively constant to maintain hydrology. Dune-blocked lakes formed at the edge of the dune sheet are the most common sites. Gently-sloping, shallow lakeshores are necessary for formation of this association.

Vegetation and ecology. The tree layer is sparse in most stands, with scattered red alder, shore pine or Sitka spruce growing on low hummocks or around the margin of the wetland. A dense, tangled layer of tall shrubs, dominated by crabapple and Hooker willow, forms a canopy ranging from 30-95 percent cover. Douglas spiraea and Labrador tea form a lower shrub layer on wet soils, especially in gaps in the canopy of tall shrubs. Salal and black twinberry may occur on hummocks. The ground layer is dominated by slough sedge and skunk cabbage, with areas of bare, wet muck in the most shaded places. Mosses and licorice fern are abundant in the canopy of tall shrubs. Stands appear to be long-lived, maintained by wet soils and gap succession. The willow sustains frequent crown damage from winter winds, as well as from heavy browsing by beavers, followed by vigorous sprouting. While crabapple is present on the Recreation Area, it did not occur in our plots. We consider the lack of crabapple to be only a local variant of this widespread and common association.

Succession. Mid seral. The slough sedge and Douglas spiraea associations are the most likely precursors to this association, and persist in gaps in the tall shrub canopy. It is replaced by the climax Sitka spruce-red alder/slough sedge-skunk cabbage association.

Distribution and history. This association is common along the coast between northern California and British Columbia. It is not common on the Recreation Area, because most lakes are steep-sided, and most deflation plain soils have little organic content. The best examples were seen at Threemile Lake, in an abandoned meander of Siltcoos River near Lagoon Campground, and around the edges of Horsfall and Spirit Lakes. Crabapple has also been called *Pyrus fusca*.

Management. Because of the dense, nearly impenetrable shrub layer, these sites are virtually free of human disturbance. They are prime feeding and denning habitat for beaver. Perennially wet soils preclude establishment of conifers for many years.

Other studies. This association was described by Christy (1980, 1985), Banner et al. (1986), and Kunze (1994).

Common plants of the Hooker willow-crabapple/
slough sedge-skunk cabbage association (n = 2
recon plots).

	Const.	Ave. cov. (%)	Range cov. (%)
OVERSTORY TREES			
Red alder	100	9	2-15
Sitka spruce	50	2	0-3
Shore pine	50	2	0-3
SHRUBS AND WOODY GROUNDCOVER			
Hooker willow	100	55	30-80
Labrador tea	100	10	10
Salal	100	3	1-5
Evergreen huckleberry	100	1	1
Sitka willow	50	8	0-15
Douglas spiraea	50	1	0-1
Black twinberry	50	1	0-1
Wax myrtle		50	10-1
HERBS, FERNS AND GRAMINOIDS			
Slough sedge	100	40	40
Skunk cabbage	100	28	5-50
Lady fern	100	2	2
Licorice fern	100	2	1-2
Deer fern	100	1	1
Sword fern	100	1	1

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DWARF-SHRUBLAND ASSOCIATIONS

Bog blueberry/slough sedge dwarf-shrubland (VAUL/CAOB3)	84
Bog blueberry/tufted hairgrass dwarf-shrubland (VAUL/DECEC)	86



The bog blueberry/slough sedge association on a deflation plain.

BOG BLUEBERRY SEASONALLY FLOODED DWARF-SHRUBLAND ALLIANCE

VAUL/CAOB3
VAUL/DECEC

BOG BLUEBERRY/SLOUGH SEDGE DWARF-SHRUBLAND

Juncus uliginosus/Carex obnupta



VAUL/CAOB3
(Sampled: 10 recon plots)
SW4102

Environment. This wetland association occurs primarily on deflation plains. Stands are seasonally flooded and may dry out in summer. The substrate is organic material from two to 20 inches thick, underlain by sand. Stands are remote from saltwater intrusion, but may be subject to salt spray.

Vegetation and ecology. This association occupies sites similar to those of the Hooker willow/slough edge-Pacific silverweed association. It is dominated by bog blueberry and has a comparatively low cover of Hooker willow. The tree layer is sparse, composed of young shore pine, with reproduction of rabapple and shore pine present. Salal and evergreen huckleberry are sporadic and confined to drier hummocks. The ground layer is dominated by slough sedge, Pacific silverweed, salt rush and other species common to deflation plains. Eastern cranberry, escaped from cultivated stock, is sometimes present in this association. Mosses average 11 percent cover, ranging from 0-45 percent. Common species include *Polytrichum commune* and *Warnstorfia exannulata*.

Succession. Early seral. Like the slough sedge-Pacific silverweed association, this association appears to be derived from the creeping spikerush-Nevada rush association. If no sand burial or drainage occurs, the shore pine/slough sedge association will develop on these sites. If some sand burial or drainage occurs, the bog blueberry/tufted hairgrass association may replace the bog blueberry/slough sedge association.

Distribution and history. This association occurs sporadically along the coast between northern California and southwestern Washington. On the Recreation Area, good examples can be seen on deflation plains in the Horsfall area. The eastern cranberry occurring in our plots probably originated from nearby plantings on private land, where it has been grown commercially since 1885. There are

several abandoned cranberry bogs on the Recreation Area west and south of Hauser, and the species is readily bird-dispersed into native wetlands.

Management. Off-road vehicles can cause considerable damage to seasonally-flooded areas on deflation plains. However, most drivers prefer herb-dominated habitats, and avoid shrubby areas such as the bog blueberry/slough sedge association.

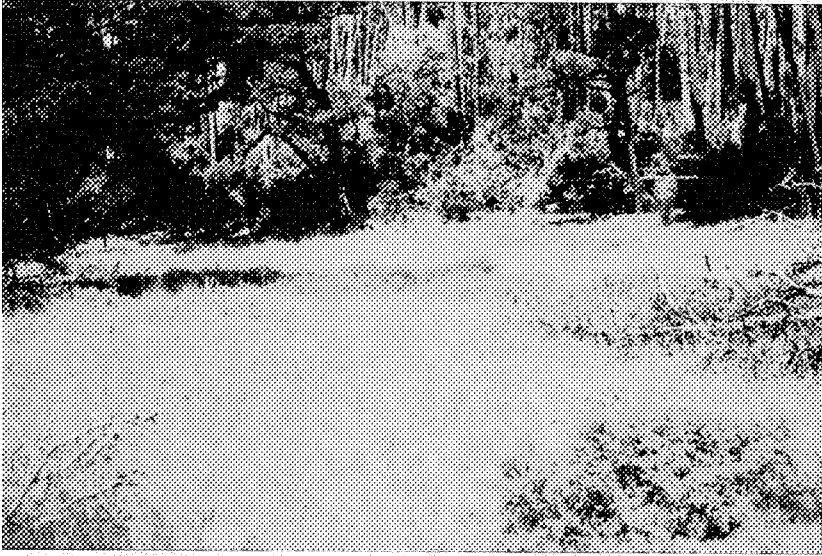
Other studies. Egler (1934) described a slough sedge-dwarf huckleberry (*Vaccinium caespitosum*) association on deflation plains. It is likely that Egler misidentified bog blueberry as dwarf huckleberry. Although dwarf huckleberry is known to occur at higher elevations in the Coast Range, it is unknown from the immediate coast. Bog blueberry associations occur north to Alaska (Viereck et al. 1992), but slough sedge does not extend north of British Columbia.

Common plants of the bog blueberry/slough sedge association (n = 10 recon plots).

	Const.	Ave. cov. (%)	Range cov. (%)
OVERSTORY TREES			
Shore pine	20	2	0-20
UNDERSTORY TREES			
Shore pine	70	2	0-10
Crabapple	10	Tr	0-2
SHRUBS AND WOODY GROUNDCOVER			
Bog blueberry	100	54	35-80
Hooker willow	90	13	0-35
Labrador tea	50	1	0-5
Salal	50	1	0-3
Evergreen huckleberry	40	1	0-5
Eastern cranberry	30	17	0-80
Douglas spiraea	30	2	0-10
Wax myrtle	30	2	0-15
HERBS, FERNS AND GRAMINOIDS			
Slough sedge	100	27	2-60
Marsh speedwell	90	2	0-5
Pacific silverweed	80	9	0-40
Salt rush	60	2	0-10
Creeping buttercup	50	Tr	0-1
California aster	40	2	0-20
Northern bugleweed	40	1	0-2

BOG BLUEBERRY/TUFTED HAIRGRASS DWARF-SHRUBLAND

Vaccinium uliginosum/Deschampsia cespitosa ssp. *cespitosa*



VAUL/DECEC
(Sampled: 3 recon plots)
SW4101

Environment. Never large in extent, this association occurs infrequently in shallow depressions on old deflation plains, around the edges of shallow dune lakes, and in sandy areas underlain by iron-cemented hardpan. Stands are seasonally flooded to a depth of 12 inches, and usually dry out by midsummer. Substrate is sand or a thin organic layer over sand.

Vegetation and ecology. The stands sampled on the Recreation Area contained more wetland species than others seen in the region, but were sampled during a wet summer when areas remained flooded longer than usual. The tree layer is sparse, mostly restricted to the periphery of stands, and is composed of shore pine only. The shrub layer is dominated by bog blueberry, with cover up to 40 percent. Douglas spiraea may have up to 25 percent cover, and Hooker willow up to 10 percent cover. Sites sampled outside of the Recreation Area have had up to 90 percent cover of bog blueberry, 25 percent cover of Douglas spiraea, and up to 10 percent cover of Hooker willow. Hooker willow sometimes has higher constancy than bog blueberry, but cover values are much lower than those of bog blueberry. Lesser amounts of evergreen huckleberry, salal and wax myrtle may occur on elevated hummocks or around the margins. The herb layer is dominated by tufted hairgrass with up to 60 percent cover, with up to 80 percent in plots seen elsewhere, and may contain 20-30 percent cover of slough sedge. Bracken fern may be present in trace amounts. The moss *Sphagnum mendocinum* and the lichen *Cladonia portentosa* ssp. *pacifica* occur at some sites.

Succession. Early seral. This association is probably preceded by the wetter bog blueberry/slough sedge association. Invading upland species indicate that it is replaced by the shore pine-Sitka spruce/evergreen huckleberry association.

Distribution and history. This association is apparently restricted to the immediate coastline between northern California and Heceta Head, Oregon. It appears to be declining because of successional changes caused by dune stabilization, and possibly by cessation of stand-replacing fires. It is also vulnerable to recreational and residential development. On the Recreation Area, small examples occur along the shore of Threemile Lake.

Management. Some stands are adjacent to areas favored for mushroom picking. Areas are usually too small or remote to be subject to off-road vehicle entry, but they can be damaged if entered. Stands larger than 2 or three acres, if found, should be protected and monitored, with removal of encroaching shrubs and trees by cutting. Threats from development are greatest between the Siuslaw River and Heceta Head.

Other studies. Martin and Frenkel (1978) described this association.

Common plants of the bog blueberry/tufted hairgrass association (n = 3 recon plots).

	Const.	Ave. cov. (%)	Range cov. (%)
OVERSTORY TREES			
Shore pine	33	2	0-5
UNDERSTORY TREES			
Crabapple	33	1	0-2
Cascara	33	Tr	0-1
Shore pine	33	Tr	0-1
SHRUBS AND WOODY GROUNDCOVER			
Hooker willow	67	2	0-5
Bog blueberry	33	13	0-40
Douglas spiraea	33	2	0-5
Wax myrtle	33	Tr	0-1
Salal	33	Tr	0-1
HERBS, FERNS AND GRAMINOIDS			
Tufted hairgrass	100	38	10-60
Slough sedge	100	7	1-20
Toothed Australian fireweed	67	2	0-5
Pacific silverweed	67	1	0-2
Marsh speedwell	67	1	0-2
Field mint	67	Tr	0-1

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EUROPEAN BEACHGRASS HERBACEOUS VEGETATION

Ammophila arenaria



AMAR4

(Sampled: 15 recon plots,
80 transect plots)

GR8211

Environment. This association is present throughout the dune sheet, from upper beaches to the forest edge, and occurs in open areas on all aspects and slopes. European beachgrass is best developed on foredunes, hummocks on deflation plains, and margins of winter transverse dunes, where seasonal sand movement is extensive. It tolerates salt spray on beaches and foredunes, continual burial by sand, and droughty conditions throughout the summer.

Vegetation and ecology. The herb layer of this association is dominated by nearly monotypic stands of European beachgrass, with 20-90 percent cover. There may be up to 75 percent bare sand. Introduced weedy species such as false dandelion, little hairgrass and silver hairgrass are frequent. Native dune species such as American dunegrass, seashore lupine and coast strawberry persist in these stands as relicts of native dune associations. Because most stands of European beachgrass occur on youthful sand dunes, many still actively shifting, woody species are nearly absent. Scots broom and tree lupine were sometimes interplanted with European beachgrass, and have also naturalized. Native shrubs such as salal, Hooker willow and wax myrtle occur in marginal stands that are succeeding to other types of associations. American beachgrass (*Ammophila breviligulata*), native to the east coast of North America, becomes common on dunes around the mouth of the Columbia River, but has not been reported from the Recreation Area.

While many stands of this introduced species were planted in dune stabilization programs, the majority appears to have invaded most localities by seed or vegetative propagation. European beachgrass is responsible for the buildup of large foredunes and creation of broad deflation plains, which have cut off the supply of beach sand to dunes further inland. Its competitive superiority and sand-trapping ability have enabled it to infiltrate and destroy nearly all stands of native plant associations on open, partially-stabilized dunes (Wiedemann 1984, 1990, 1993; Boyd 1992; Wiedemann and Pickart 1996).

Succession. Early seral. European beachgrass is a pioneer on bare, shifting sand. On foredunes and exposed interior dunes, it can replace native stands of the American dunegrass, seashore lupine, seashore bluegrass, and red fescue associations. On hummocks and deflation plains, European beachgrass can also replace the salt rush and red fescue-salt rush associations. Once sand movement diminishes, stands of European beachgrass are replaced by either the tree lupine/European beachgrass or the shore pine/Scots broom/European beachgrass associations. The successional pathways outlined here follow a hypothetical linear progression, influenced by the availability of shifting sand and the competitive ability of European beachgrass. Rejuvenation of sand movement in previously stabilized areas, or *de novo* infiltration or burial by sand, can trigger invasion by European beachgrass in nearly any association in nearly any locality in the Recreation Area. The putative successional sequence would then start over with European beachgrass, instead of whatever had been growing there previous to the advent of new sand.

Distribution and history. The European beachgrass association is common along the coast between northern California and British Columbia. On the Pacific coast of North America, it was first planted in California around 1890 (Davy 1902). On the Recreation Area, it was first planted on the North Spit around 1910. It began to spread naturally by 1930, and subsequently was planted widely until about 1970 (McLaughlin 1939; Arnst 1942; McLaughlin and Brown 1942; Meyer and Chester 1977). By 1970, it had spread the entire length and breadth of the dune sheet. In northern California dunes, 50 years of aerial photography show that the grass has increased its cover 574 percent, spreading at an average rate of 2.5 acres per year between 1939 and 1962, and 12 acres per year between 1962 and 1989 (Buell 1992). On the Recreation Area, typical examples may be seen on any foredune.

Management. Some of the rarest plant associations on the Recreation Area are threatened because they have been invaded and replaced by European beachgrass. European beachgrass is now so widespread on the Recreation Area that it will be impossible to eradicate except in small areas. Off-road vehicles have destroyed some stands in heavily used areas (Wiedemann 1993). The experimental breach in the foredune north of Siltcoos River, excavated in 1982, has caused very little sand movement onto the deflation plain. Much larger segments of foredune would need to be breached to initiate much movement. Management efforts should be directed instead toward control of European beachgrass in local areas where endangered native plant associations need to be restored and maintained. Fire, herbicides, saltwater, mechanical, and manual methods of control have been studied. Manual removal has been the most successful method of control, and the most expensive. Projects in northern California have shown dramatic recovery of relictual native species when European beachgrass was removed (Duebendorfer 1992; Miller 1994a, 1994b; Wiedemann and Pickart 1996).

Other studies. Kunze (1985) and Wiedemann (1984, 1990, 1993) described this association clearly. It is the "beachgrass" and "European beachgrass" of Duebendorfer (1990, 1992). The European beachgrass series of Sawyer and Keeler-Wolf (1995) includes this association.

Common plants of the European beachgrass association (n = 15 recon plots).

	Const.	Ave. cov. (%)	Range cov. (%)
OVERSTORY TREES			
Sitka spruce	7	Tr	0-1
UNDERSTORY TREES			
Shore pine	33	Tr	0-2
Sitka spruce	20	Tr	0-2
SHRUBS AND WOODY GROUND COVER			
Scots broom	27	1	0-15
Salal	20	Tr	0-2
Hooker willow	13	1	0-20
Wax myrtle	13	1	0-15
Bearberry	13	1	0-5
HERBS, FERNS AND GRAMINOIDS			
European beachgrass	100	54	20-90
False dandelion	80	2	0-8
Pearly everlasting	73	1	0-5
Seashore lupine	67	2	0-8
Coast strawberry	60	2	0-10
Little hairgrass	53	2	0-10
Silver hairgrass	53	1	0-10
Yarrow	40	Tr	0-2

AMERICAN DUNEGRASS HERBACEOUS VEGETATION

Leymus mollis spp. *mollis*



LEMOM2

(Sampled: 4 recon plots,
1 transect plot)
GR8213

Environment. This association can be found on beaches and in foredunes, and to a lesser extent on open deflation plains and in upper estuaries. Stands are exposed to salt spray, nearly continuous winds, abrasion, and ongoing burial by shifting sands.

Vegetation and ecology. Stands on well-drained upper beaches and foredunes are typically species-poor, with up to 70 percent bare sand. Sea pea is usually a conspicuous associate. Continual sand burial and inputs of salt spray on beaches, foredunes and exposed areas on deflation plains seem necessary for American dunegrass to thrive. A variant expression occurs on deflation plains and in upper estuaries, where additional moisture allows many more species to grow. These may have a total herb cover approaching 100 percent, and weedy species typical of the salt rush association may be conspicuous. Stands in most locations have been overrun by European beachgrass, but American dunegrass often persists in patches among the European beachgrass.

Succession. Early seral. At most sites on the Recreation Area, the European beachgrass association completely replaces the American dunegrass association. In the absence of European beachgrass, in slightly more stable areas, the American dunegrass association is replaced by the seashore bluegrass association.

Distribution and history. The American dunegrass association was once the dominant native vegetation on upper beaches and discontinuous, hummocky native foredunes. It originally ranged along the coast from northern California (Davy 1902) to southeastern Alaska. It is in decline throughout the region because of the ubiquitous invasion of European beachgrass. The best remaining examples can be seen at Lanphere-Christensen Dunes Preserve near Arcata, California (Wiedemann 1990). The species was used to a limited extent in stabilization plantings (McLaughlin and Brown 1942). Today, natural stands of this association are rare, and need protection. On the Recreation Area, small stands can

be seen on the South Jetty, and in the estuary of Tenmile Creek. This species has also been called *Elymus mollis*.

Management. The association tolerates dispersed foot traffic, but cannot sustain off-road vehicle traffic. Management should include restoration of some native foredunes, where some of the original components and local genotypes of this species can still be found.

Other studies. This association has been described by Johnson (1963), Parker (1974), Kunze (1983, 1985), Wiedemann (1984, 1990, 1993), and LaBanca (1993). This is the "northern foredune grassland" of Duebendorfer (1992), and the native dunegrass series of Sawyer and Keeler-Wolf (1995).

Common plants of American dunegrass association
(n = 4 recon plots).

	Const.	Ave. cov. (%)	Range cov. (%)
HERBS, FERNS AND GRAMINOIDS			
American dunegrass	100	69	50-85
Sea pea	100	31	20-45
Salt rush	75	1	0-15
Yarrow	75	1	0-1

RED FESCUE HERBACEOUS ALLIANCE

FERU2
FERU2-JULE
FERU2-PTAQ

RED FESCUE HERBACEOUS VEGETATION

Festuca rubra



FERU2
(Sampled: 10 recon plots,
8 transect plots)
GM2001

Environment. The red fescue association once dominated well-drained, sand dunes with limited sand movement. The best remaining examples occur on partially-stabilized parabola dunes and slopes along the eastern edge of the dune sheet, adjacent to forest stands, where sites are somewhat sheltered from winds. All aspects and microtopography are represented.

Vegetation and ecology. Stands are typically species-poor, with individual fescue plants often spaced 1-4 feet apart. Bare sand varies from 20-90 percent, graminoid cover from 10-35 percent and herb cover from 1-30 percent. Beach knotweed and beach silvertop are conspicuous associates. On stable sites where other species have not invaded, red fescue can occasionally form a turf with seashore lupine dominant. Red fescue persists only on relatively inactive sand. It sustains dispersed foot traffic, and to a lesser extent dispersed off-road vehicle traffic, but single vehicle tracks sometimes can leave long-lasting scars. Stands in many locations have been destroyed by intense off-road vehicle traffic, trampling, and occasional invasion by European beachgrass.

Succession. Early seral. This association can persist for decades if left undisturbed. Stands of this type are preceded by either the seashore bluegrass or the seashore lupine associations, both of which have more sand movement. It is replaced by either the red fescue-bracken fern association, or the shore pine/bearberry association. In most cases, European beachgrass loses vigor with the reduced movement of sand characteristic of sites dominated by red fescue. However, we have seen instances where the red fescue association has been replaced by the European beachgrass association, mostly at sites with greater exposure to wind.

Distribution and history. This association originally ranged along the coast from northern California (Davy 1902) to British Columbia. It is in decline throughout the region because of intense off-road

vehicle traffic, trampling, and occasional invasion by European beachgrass. The species was used to a limited extent in stabilization plantings (McLaughlin and Brown 1942). Some of the best remaining sites on the Recreation Area can be seen on dunes along the east edge of the dune sheet, north and south of the Eel Creek Campground, and south of the Threemile Creek road.

Management. Today, natural stands of this association are one of the rarest on the Recreation Area, and need protection. Of all dune vegetation in northern California, Brown (1990), Pickart (1990), and Duebendorfer (1992) identified the red fescue association as being the most vulnerable to trampling and vehicular damage. Stands are destroyed by off-road vehicle traffic and concentrated foot traffic. Management should include restoration, protection and monitoring of the best remaining stands, with control of European beachgrass when needed.

Other studies. Wiedemann (1984, 1990, 1993), Wiedemann et al. (1969), and Kunze (1983, 1985) described this association clearly. Pickart (1987) described a "dune mat" association that contained elements of our concept of the red fescue association.

Common plants of the red fescue association
(n = 10 recon plots).

	Const.	Ave. cov. (%)	Range cov. (%)
HERBS, FERNS AND GRAMINOIDS			
Red fescue	100	20	5-35
Beach knotweed	90	1	0-2
False dandelion	70	1	0-3
Seashore bluegrass	60	3	0-10
Seashore lupine	50	8	0-35
Beach silvertop	50	1	0-2
Pearly everlasting	50	Tr	0-1
Coast strawberry	50	Tr	0-1

RED FESCUE-SALT RUSH HERBACEOUS VEGETATION

Festuca rubra-*Juncus lesueurii*



FERU2-JULE
(Sampled: 6 recon plots)
GM2003

Environment. This association is unique to seasonally moist soils on deflation plains, deflated dune hollows, and in estuarine areas remote from salt intrusion. Topographically, stands are slightly higher and farther removed from the water table than is the salt rush association. The substrate is sand, with little organic material.

Vegetation and ecology. The red fescue-salt rush association occurs at the dry end of a moisture gradient on deflation plains (Newman 1983). The water table recedes to about 28 inches below the surface in summer. Because of its wide tolerance of soil moisture, salt rush is of little value in distinguishing wet from dry soils. Red fescue, little hairgrass, European centaury, and seashore lupine are better indicators of drier soil conditions. Herb cover ranges from 25-99 percent. Well-developed stands form meadows with little bare sand. The association is distinguished from the red fescue association by its location on seasonally moist deflation plains, high species diversity, high percent cover, and sods or turfs of red fescue, in contrast to the widely-spaced individual plants in the red fescue association. Additional moisture availability on deflation plains allows many more species to grow, producing one of the richest herb layers on the Recreation Area, many of them annual or biennial Eurasian weeds (Table 5). High species diversity is correlated with high light levels, areas of bare sand available for seasonal colonization by annuals and biennials, and a seasonally-fluctuating water regime that allows for favorable germination and establishment. Rapid invasion by salal, evergreen huckleberry, shore pine and Sitka spruce converts stands to impenetrable thickets.

Succession. Early seral. In the absence of European beachgrass, this association is preceded by the salt rush association. Evidence for this is the presence of high species diversity, a significant component of salt rush, and microposition on deflation plains. As invasion by conifers begins, it is replaced by the shore pine-Sitka spruce/ evergreen huckleberry association. In areas with rejuvenated sand movement, it may also be invaded and replaced by the European beachgrass association.

Distribution and history. This association occurs along the coast between northern California and British Columbia. It has probably increased in area since enlargement of deflation plains, caused by the advent of European beachgrass. On the Recreation Area, it is most easily seen at the outlet of Siltcoos

River. The association was once grazed by livestock at Goose Pasture, most of which has since become a stand of 50-year-old Sitka spruce. Red fescue was also seeded on deflation plains in the 1960's for wildlife habitat improvement (Wiedemann 1984).

Management. Stands not invaded by woody species are especially vulnerable to damage by off-road vehicles. Stands may be managed by cutting or limited use of fire, to remove exotic species of herbaceous and woody plants.

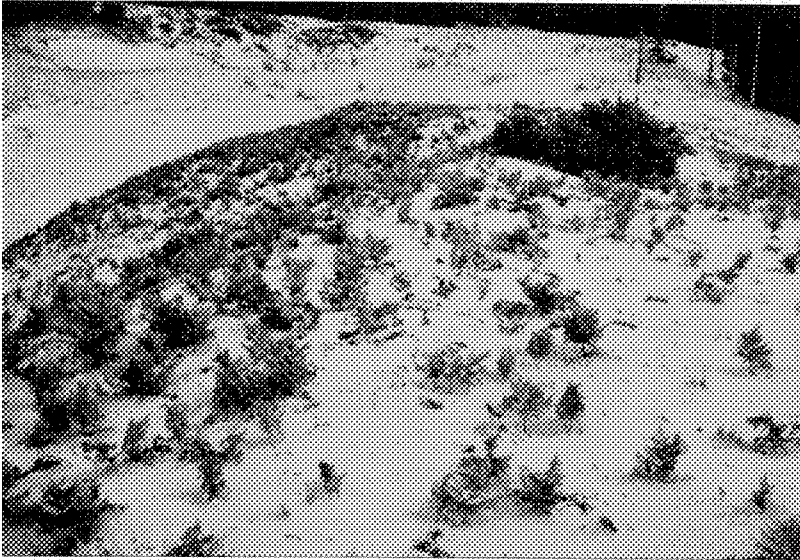
Other studies. Wiedemann et al. (1969) treated this association as a variant of their "meadow" association. Wiedemann (1984, 1993) treated it as a red fescue-seashore lupine association. Duebendorfer (1992) described a "brackish marsh" similar to the red fescue-salt rush association, but our concept of this association is freshwater.

Common plants of the red fescue-salt rush association (n = 6 recon plots).

	Const.	Ave. cov. (%)	Range cov. (%)
UNDERSTORY TREES			
Sitka spruce	33	Tr	0-1
Shore pine	33	Tr	0-1
SHRUBS AND WOODY GROUNDCOVER			
Salal	67	3	0-12
Wax myrtle	67	1	0-2
Scots broom	50	1	0-1
Evergreen huckleberry	50	1	0-1
Hooker willow	33	1	0-3
HERBS, FERNS AND GRAMINOIDS			
Red fescue	100	23	9-35
Salt rush	100	10	1-25
False dandelion	83	4	0-15
Little hairgrass	67	4	0-15
European centaury	67	1	0-2
Nevada rush	50	8	0-30
Tufted hairgrass	50	7	0-35
Velvet grass	50	6	0-20
Gumweed	50	5	0-25
Coast strawberry	50	2	0-8
Sheep sorrel	50	2	0-5
Spring-bank clover	50	1	0-5
Pacific silverweed	50	1	0-3
Silver hairgrass	50	1	0-2
Slough sedge	50	1	0-2
California aster	50	1	0-2
English plantain	50	1	0-1

RED FESCUE-BRACKEN FERN HERBACEOUS VEGETATION

Festuca rubra-*Pteridium aquilinum*



FERU2-PTAQ
(Sampled: 3 recon plots)
GM2002

Environment. The red fescue-bracken fern association occurs on slopes and tops of stabilized dunes, usually near the edge of the forest along the eastern edge of the dune sheet, or on the landward side of forest islands. The sand is droughty, and has little or no accumulation of organic matter. Some sand movement is present, and wind erosion may destroy some sites.

Vegetation and ecology. Stands occur on open, well-drained sites with little or no woody vegetation present. Bracken fern growing 1-3 feet tall dominates stands, with scattered bunches of red fescue and other herbs beneath. Bare sand ranges from 30 to 75 percent cover, with plants spaced 1 to 3 feet apart. Sand movement inhibits development of moss or lichen layers. Cover of bracken fern ranges from 15 to 40 percent, and herb cover from 1 to 30 percent. Seashore bluegrass, seashore lupine and beach silvertop are usually present in small numbers. Bracken fern spreads by an aggressive network of tough rhizomes, resistant to wind erosion. Some stands may be quite old, as bracken fern appears to be long-lived, and persists in considerable amounts in later seral stands dominated by shore pine and Douglas fir, as long as the canopy remains open, and the shrub layer thin or absent. It is possible that bracken fern invades red fescue stands occurring near forest stands, rather than originating *de novo* by propagules. In some places it could also be a long-lived relict of a previously forested surface buried by sand.

Succession. Early seral. The red fescue-bracken fern association replaces the red fescue association in certain sites, particularly near the forest edge. It is in turn replaced by the shore pine/bearberry association.

Distribution and history. This association occurs along the coast between northern California and northwestern Washington. On the Recreation Area, stands may be seen on the Umpqua Dunes, and in partially-stabilized areas north and south of Eel Creek Campground.

Management. Poorly-consolidated sands and sparse vegetative cover makes these stands vulnerable to damage by off-road vehicles.

Other studies. This association apparently has not been described from coastal dunes.

Common plants of the red fescue-bracken fern
association (n = 3 recon plots).

	Const.	Ave. (%)	Range cov. (%)
UNDERSTORY TREES			
Shore pine	67	4	0-10
SHRUBS AND WOODY GROUNDCOVER			
Bearberry	33	2	0-5
Scots broom	33	Tr	0-1
HERBS, FERNS AND GRAMINOIDS			
Bracken fern	100	25	15-40
Red fescue	100	6	1-15
Seashore bluegrass	100	1	1-1
Seashore lupine	67	15	0-30
Beach silvertop	67	1	0-1
False dandelion	33	1	0-2
Sheep sorrel	33	Tr	0-Tr
Beach knotweed	33	Tr	0-Tr

SALT RUSH HERBACEOUS ALLIANCE

JULY

SALT RUSH HERBACEOUS VEGETATION

Juncus lesueurii



JULY

(Sampled: 7 recon plots,
29 transect plots)
MMB801

Environment. This association is unique to deflation plains, hummocks and dune hollows. Stands may be flooded in winter, but dry out by early summer. The substrate is sand, with an average of 19 percent exposed, ranging from 0-60 percent. Conditions limiting greater vegetative cover may be duration of winter flooding, followed by summer drought. Topography is more elevated than that of the sickle-leaved rush-salt rush association, because of sand infilling or drainage. Sand movement is limited or nonexistent.

Vegetation and ecology. The salt rush association occurs at the dry end of a seasonal moisture gradient on deflation plains (Newman 1983). The water table recedes to about 28 inches below the surface in summer. Because of its wide tolerance of soil moisture, salt rush is of little value in distinguishing wet from dry soils. Little hairgrass, seashore lupine, and European centaury are better indicators of seasonally drier soil conditions. This association has one of the richest herb layers on the Recreation Area, many of them annual or biennial Eurasian weeds (Table 5). High diversity may result from the large amount of bare sand available for colonization, combined with moisture availability in the spring for germination and establishment. It is rapidly invaded by woody species. Young shore pine occurred in more than half the plots, but cover averaged only 3 percent and ranged from 0-15 percent. Conifer reproduction is dominated by shore pine, and to a lesser extent Sitka spruce, but cover of both is scant. The shrub layer is sparse, with an average of 5 percent cover, ranging from 0-20 percent. Scots broom is the most common species, with lesser amounts of Hooker willow. The herb layer averages 69 percent

total cover, and is dominated by salt rush, false dandelion and little hairgrass, each averaging less than 15 percent cover. Moss cover is negligible. Salt rush can trap sand and initiate formation of hummocks. It also tolerates sand burial and can persist in dry associations as a relic of formerly wet, buried landforms.

Succession. Early seral. This association is preceded by the sickle-leaved rush-salt rush association, occurring on slightly wetter ground, and with higher overall vegetative cover. Stands are replaced by the red fescue-salt rush association. Rejuvenated movement of sand could initiate conversion to the European beachgrass association.

Distribution and history. This association occurs along the coast between northern California and British Columbia. It has probably increased in area since enlargement of deflation plains, caused by the advent of European beachgrass. On the Recreation Area, it can be seen on relatively dry deflation plains as long as the sites have not been overrun by woody species.

Management. The only recreational impact to this association is done by off-road vehicles, where machines may churn up what little vegetation is present.

Other studies. Egler (1934) described a rush association composed of five phases determined by moisture gradients and the duration on winter flooding. Wiedemann (1966, 1984, 1990) and Wiedemann et al. (1969) included this association in a broader concept of a "dry meadow" association, dominated by Nevada rush, sickle-leaved rush and spring-bank clover. Pickart (1990) described a salt rush type from a slightly drier phase of her "dune hollow" association.

Common plants of the salt rush association (n = 7 recon plots).

	Const.	Ave. cov. (%)	Range cov. (%)
OVERSTORY TREES			
Shore pine	57	3	0-15
UNDERSTORY TREES			
Shore pine	71	2	0-5
Sitka spruce	29	Tr	0-1
SHRUBS AND WOODY GROUNDCOVER			
Scots broom	71	2	0-8
Hooker willow	57	3	0-15
Salal	29	Tr	0-1
HERBS, FERNS AND GRAMINOIDS			
Salt rush	100	12	2-25
False dandelion	100	9	1-20
Little hairgrass	86	11	0-40
Slough sedge	86	7	0-25
Seashore lupine	71	6	0-35
European centaury	71	2	0-10
Purple cudweed	71	2	0-6
Silver hairgrass	57	4	0-15
Coast strawberry	57	1	0-3
Sheep sorrel	57	1	0-3
California aster	57	1	0-1

SICKLE-LEAVED RUSH HERBACEOUS ALLIANCE

JUFA-JULE

SICKLE-LEAVED RUSH-SALT RUSH HERBACEOUS VEGETATION

Juncus falcatus-Juncus lesueurii



JUFA-JULE

(Sampled: 10 recon plots,
29 transect plots)
MMB802

Environment. This association is unique to deflation plains and dune hollows. Stands may be flooded in winter, but dry out by early summer, when the water table drops to about 12-18 inches below the ground surface. The substrate is sand, sometimes with a thin layer of organic material, with only an average of 9 percent exposed. Because of sand infilling or drainage, topography is more elevated than that of either the Baltic rush-Pacific silverweed association, or the creeping spikerush-Nevada rush association. Sand movement is limited.

Vegetation and ecology. The sickle-leaved rush-salt rush association occurs at the wet end of a moisture gradient on deflation plains (Newman 1983). Averaging 20 inches below the surface in summer, the water table is eight inches closer than in either the salt rush or red fescue-salt rush associations. Because of their wide tolerance of soil moisture, sickle-leaved rush and salt rush are of little value in distinguishing wet from dry soils. Slough sedge, Pacific silverweed and creeping buttercup are better indicators of wetter soil conditions. Presence of golden-eyed grass suggests that this association occurs on deflation plain surfaces that have been available for colonization for at least 40 years (Newman 1983). Trees and shrubs, usually not over 5 or 6 feet tall, include shore pine, Sitka spruce, Hooker willow, salal, evergreen huckleberry, and wax myrtle. Woody material averages less than 20 percent cover, but rarely may be as high as 60 percent. Herb cover averages 55 percent, ranging from 0-80 percent, and species diversity is one of the highest on the Recreation Area (Table 5). High species diversity is correlated with high light levels, areas of bare sand available for seasonal colonization by annuals and biennials, and a seasonally-fluctuating water regime that allows for favorable germination and establishment. Sickle-leaved rush and salt rush are the dominant species, but many others are present with high constancy but low cover values. Moss cover varies from 0-30 percent. A weedy phase may include up to 60 percent cover of bird-foot trefoil, a Eurasian species planted for wildlife forage and subsequently escaped, with lesser amounts of other introduced species such as

parentucellia, sweet vernal grass, and false dandelion. Summer drying on these sites enables relatively rapid invasion of woody species.

Succession. Early seral. This association replaces the wetter Baltic rush-Pacific silverweed association. It is in turn replaced by the salt rush association of better-drained sites.

Distribution and history. The sickle-leaved rush-salt rush association occurs along the coast between northern California and southwestern Washington. It has probably increased in area since enlargement of deflation plains, caused by the advent of European beachgrass. On the Recreation Area, it can be seen on relatively dry deflation plains, as long as the sites have not been overrun by woody species. The weedy phase with bird-foot trefoil can be seen at Goose Pasture.

Management. The only recreational impact to this association is off-road vehicles, where machines may churn up what little vegetation is present.

Other studies. Egler (1934) described a rush association composed of five phases determined by moisture gradients and the duration of winter flooding. Wiedemann (1966, 1984, 1990, 1993) and Wiedemann et al. (1969) included this association in a broader concept of a "rush meadow" association, dominated by Nevada rush, sickle-leaved rush and spring-bank clover. Kunze (1994) described a sickle-leaved rush-Nevada rush association similar to this, but lacking salt rush.

Common plants of the sickle-leaved rush-salt rush association (n = 10 recon plots).

	Const.	Ave. cov. (%)	Range cov. (%)
OVERSTORY TREES			
Shore pine	10	Tr	0-1
UNDERSTORY TREES			
Shore pine	70	2	0-10
Sitka spruce	20	Tr	0-1
SHRUBS AND WOODY GROUNDCOVER			
Hooker willow	100	20	1-60
Salal	50	2	0-10
Evergreen huckleberry	50	1	0-2
Wax myrtle	40	4	0-25
Labrador tea	20	2	0-20
Scots broom	20	Tr	0-1
Red elderberry	10	Tr	0-1
HERBS, FERNS AND GRAMINOIDS			
Sickle-leaved rush	100	23	1-70
False dandelion	100	2	1-5
Salt rush	90	12	0-40
Slough sedge	90	4	0-15
Golden-eyed grass	80	2	0-5
Pacific silverweed	70	3	0-15
Green sedge	60	1	0-3
California aster	60	1	0-2
European centaury	60	1	0-1
Nevada rush	50	5	0-30
Creeping buttercup	50	3	0-20
Giant helleborine	50	1	0-5
Shore sedge	50	1	0-3
Coast strawberry	50	1	0-2

EASHORE BLUEGRASS HERBACEOUS VEGETATION

oa macrantha



POMA26

(Sampled: 1 recon plot,
20 transect plots)

GM8001

Environment. The seashore bluegrass association was once common on well-drained foredunes, dry deflation plains, and partially-stabilized dunes further inland. The best remaining examples occur on partially-stabilized slopes and flats along the eastern edge of the dune sheet.

Vegetation and ecology. Stands are typically sparse and species-poor, with 75-98 percent bare sand. Red fescue, seashore lupine, beach knotweed and beach silvertop are frequent associates. Seashore bluegrass is adapted to intermediate rates of sand burial, but cannot survive extensive sand movement. Stands in most locations have been overrun by European beachgrass or eradicated by intense off-road vehicle traffic.

Succession. Early seral. In areas where movement of sand begins to diminish, the seashore bluegrass association may develop *de novo*, or replace the American dunegrass association. With increasingly less sand movement, it is in turn replaced by the red fescue association. Most sites, however, have been overrun and replaced by the European beachgrass association.

Distribution and history. This association originally occurred along the coast between northern California (Davy 1902) and southwestern Washington. It is in decline throughout the region because of the widespread invasion of European beachgrass, and damage from intense off-road vehicle use. Today, natural stands of this association are one of the rarest on the Recreation Area, and need protection. One of the few remaining sites can be seen north of Eel Creek Campground. Others occur north of Florence in the Sutton Creek Recreation Area, and in the Sand Lake Research Natural Area in Tillamook County.

Management. Stands tolerate dispersed foot and off-road vehicle traffic, but not sustained traffic of either sort. Management should include protection and monitoring of the best remaining stands, with control of European beachgrass when needed.

Other studies. Most studies from the region (Egler 1934; Byrd 1950; Kumler 1963, 1969; Wiedemann 1966, 1984, 1990; Kunze 1983, 1985) included seashore bluegrass as a species codominant with large-headed sedge, yellow sandverbena or seashore lupine, all occurring on foredunes, dry deflation plains, or dunes farther inland. Large-headed sedge and yellow sandverbena are now uncommon on the Recreation Area, and do not appear to be a major component of dune plant associations. The "seashore bluegrass-beach pea phase" of the "dune mat" association of Pickart (1987) and Duebendorfer (1990, 1992), and the sand-verbena-beach bursage series of Sawyer and Keeler-Wolf (1995) contain some elements of our concept of the seashore bluegrass association, but otherwise differ floristically.

Common plants of the seashore bluegrass association (n = 20 transect plots).

	Const.	Ave. cov. (%)	Range cov. (%)
HERBS, FERNS AND GRAMINOIDS			
Seashore bluegrass	100	10	1-20
Seashore lupine	35	Tr	0-2
Beach silvertop	30	Tr	0-2
Pacific silverweed	10	Tr	0-1
Red fescue	10	Tr	0-1

SLOUGH SEDGE SEASONALLY FLOODED HERBACEOUS ALLIANCE

CAOB3
CAOB3-AREGE

SLOUGH SEDGE SEASONALLY FLOODED HERBACEOUS VEGETATION

Carex obnupta



CAOB3
(Sampled: 1 recon plot)
MW8101

Environment. This association occurs in poorly-drained depressions adjacent to streams, lakes and ponds, on both the dune sheet and in foothills of the Coast Range. It is absent from deflation plains, where it is replaced by the more salt-tolerant slough sedge-Pacific silverweed association on sandy soils. The substrate is fibrous peat or muck soil. It is flooded seasonally, and saturated in summer by water just below the ground surface. Hydrology is often mediated by beaver dams.

Vegetation and ecology. These stands typically have enormous slough sedge growing on deep, perennially-wet muck soils, with little other vegetation present. Douglas spiraea is occasional. The ground layer is dominated by nearly monotypic stands of slough sedge 3-6 feet tall, with 80-95 percent cover. Individual plants may form tussocks up to 6 feet in diameter, spaced 3-6 feet apart, with conspicuous pedestaled bases separated by nearly bare expanses of wet, mucky soil. The herb layer is sparse, averaging 5 percent cover. Lady fern, bedstraw, and toothed Australian fireweed are typical species present, not all of which were present in the single stand sampled on the Recreation Area. Remnants of earlier, wetter seral types, such as hardstem bulrush or pond lily, are sometimes present. Other slough sedge associations on the Recreation Area occur on sand, or have an overstory of Hooker willow, and the sedge is usually only 1-2 feet tall. Elk and beaver often use these sites.

Succession. Early seral. This association replaces emergent marsh associations that require more surface water year-round. On the Recreation Area, these may be the simplestem bur-reed, hardstem bulrush or inflated sedge associations. Stands are eventually replaced by the red alder/salmonberry/slough sedge-skunk cabbage association, or the Hooker willow-crabapple/slough sedge-skunk cabbage association.

Distribution and history. This association has been seen only along the coasts of Oregon and southwestern Washington, where it is fairly common. It is most frequently associated with lakes and ponds east of Highway 101. Some sites are old beaver swamps, cleared for pasture and then abandoned because they were too wet for livestock. Beaver subsequently reclaimed most of these sites. On the Recreation Area, one example was seen at the north end of Threemile Lake.

Management. Wet soils preclude any recreational use. Elk and beaver use may be heavy. The association requires an adequate water supply, but needs little other maintenance.

Other studies. Pickart (1990) described a monotypic slough sedge phase occurring in wet "dune hollow" association. Kunze's (1994) slough sedge association is very similar to this one.

Common plants of the slough sedge association (n = 1 recon plot).

	Const.	Ave. cov. (%)	Range cov. (%)
HERBS, FERNS AND GRAMINOIDS			
Slough sedge	100	90	90
Toothed Australian fireweed	100	2	2
Water smartweed	100	1	1
Pond water-starwort	100	1	1
Hardstem bulrush	100	1	1
Field mint	100	1	1
Northern bedstraw	100	1	1

SLOUGH SEDGE-PACIFIC SILVERWEED HERBACEOUS VEGETATION

Carex obnupta-*Argentina egedii*



CAOB3-AREGE
(Sampled: 15 recon plots)
MW8102

Environment. This wetland association occurs on extensive areas of deflation plains and in interdunal swales. The substrate is an organic layer two to 20 inches thick, underlain by sand. Stands are seasonally flooded, and may dry out in midsummer. Although stands on deflation plains are subject to salt spray, they are freshwater and remote from areas of saltwater intrusion.

Vegetation and ecology. This association is dominated by slough sedge and Pacific silverweed, ranging from 20-90 percent cover. It may have up to 20 percent cover of shrubs, primarily Hooker willow. Around the edges, it intergrades with other deflation plain associations that share a number of the same herbaceous species. The tree layer, when present, is composed of young shore pine. The shrub layer, when present, is dominated by Hooker willow, with lesser amounts of wax myrtle, salal and evergreen huckleberry. The herb layer is the most diverse recorded on the Recreation Area, with a total of 54 species (Table 5). Bare sand may range from 0-30 percent.

Succession. Early seral. This association appears to be derived from the creeping spikerush-Nevada rush association. It is rapidly infilled by Hooker willow, and grades into the Hooker willow/slough sedge-Pacific silverweed association, following a temporal gradient and slight hydrologic gradient from wet to dry.

Distribution and history. This association is common along the coast between northern California and British Columbia. On the Recreation Area, a profile of the entire successional gradient may be seen along the South Jetty Road, with the older portions dominated by Hooker willow to the south, extending northward into monotypic stands of slough sedge and Pacific silverweed as one nears the Siuslaw River estuary. Pacific silverweed has also been called *Potentilla pacifica*.

Management. The density of Hooker willow increases as stands age, and as they are dewatered by artificial drainage, groundwater pumping or natural infilling by sand or organic debris. Off-road vehicle use may be heavy along the margins of some stands. Flooding, clearing, or limited burning will be the only way to perpetuate this association before it is invaded by shore pine and Hooker willow.

Other studies. Wiedemann et al. (1969), Wiedemann (1966, 1984, 1993) and Kunze (1983, 1985) described this association clearly. The "herbaceous hollows" association of Duebendorfer (1990, 1992) fits our concept of the slough sedge-Pacific silverweed association.

Common plants of the slough sedge-Pacific silverweed association (n = 15 recon plots).

	Const.	Ave. cov. (%)	Range cov. (%)
OVERSTORY TREES			
Shore pine	27	Tr	0-3
UNDERSTORY TREES			
Shore pine	40	1	0-8
Sitka spruce	20	Tr	0-1
SHRUBS AND WOODY GROUNDCOVER			
Hooker willow	87	4	0-15
Wax myrtle	33	1	0-10
Salal	27	3	0-40
HERBS, FERNS AND GRAMINOIDS			
Slough sedge	100	55	20-90
Pacific silverweed	93	25	0-90
Sickle-leaved rush	60	5	0-20
Creeping buttercup	60	4	0-30
Salt rush	60	2	0-15
California aster	53	1	0-5
Marsh speedwell	53	1	0-8
Spring-bank clover	53	1	0-5

INFLATED SEDGE SEASONALLY-FLOODED HERBACEOUS ALLIANCE

CAEX5

INFLATED SEDGE HERBACEOUS VEGETATION

Carex exsiccata



CAEX5

(Sampled: 3 recon plots)

MW8103

Environment. This emergent wetland association occurs in small to large, shallow basins on new and old deflation plains, and in interdunal areas further inland. Stands are usually seasonally flooded to a depth of one to three feet, or may dry out by midsummer, with the water table just below the ground surface. The substrate is sand or an organic layer to 5 inches thick.

Vegetation and ecology. Trees are absent, and the sparse shrub layer may include Douglas spiraea and hooker willow. Stands are dominated by inflated sedge with 65-90 percent cover, and herb cover ranges from 3-15 percent. Bare ground is usually absent. Slough sedge and mannagrass tolerate both seasonal and permanent flooding. Pond lily, when present, is a relic of an earlier open-water seral stage. Seasonal flooding precludes invasion of these sites by conifers.

Succession. Early seral. This association appears to replace aquatic bed associations such as pond lily and floating-leaved pondweed, that occur in deeper basins with more permanent flooding. With infilling of sediments and organic material, it is in turn replaced by either the slough sedge or Douglas spiraea associations.

Distribution and history. This association is infrequent along the coast and in the Coast Range of western Oregon. On the Recreation Area, it is currently known only between Hauser and the Horsfall area. A good example may be seen at Bluebill Lake. Some of these stands probably were grazed in the past. This species has also been called *Carex vesicaria* var. *major*. It occurs west of the Cascade Range, while *Carex vesicaria* var. *vesicaria* occurs east of the Cascades.

Management. Groundwater pumping in the Horsfall area may dewater the old deflation plains where this association occurs, and lead to invasion by upland species. Known sites should be monitored for changes in water level and composition, to determine if the water table is being lowered.

Other studies. Kunze (1994) described this association (as *Carex vesicaria*) from the Puget lowlands of western Washington. Inflated sedge (*Carex vesicaria* var. *vesicaria*) associations reported from east of the Cascade Range differ substantially in composition from those on the Recreation Area (Christy 1993).

Common plants of the inflated sedge association (n = 3 recon plots).

	Const.	Ave. cov. (%)	Range cov. (%)
SHRUBS AND WOODY GROUNDCOVER			
Douglas spiraea	67	1	0-2
Hooker willow	33	Tr	0-Tr
HERBS, FERNS AND GRAMINOIDS			
Inflated sedge	100	78	65-90
Pond lily	100	9	2-15
Slough sedge	100	3	2-5
Marsh speedwell	100	1	1-2
Northern mannagrass	67	1	0-2
Tall mannagrass	33	2	0-5
Creeping spikerush	33	2	0-5
Shore sedge	33	Tr	0-1

THREEWAY SEDGE SEASONALLY FLOODED HERBACEOUS ALLIANCE

DUAR?

THREEWAY SEDGE HERBACEOUS VEGETATION

Dulichium arundinaceum



DUAR?
(Not sampled)
WL900?

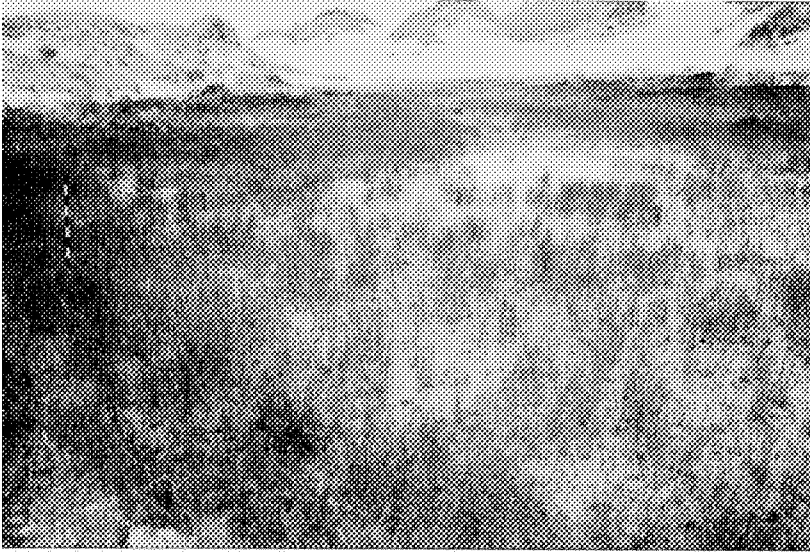
This early seral association was seen on the Recreation Area but never sampled. It forms emergent stands in shallow lakes, permanently flooded or subject to drying in summer. Most stands are monotypic, with cover ranging from 30-90 percent. The association ranges from the southern coast of Oregon, north to Alaska. On the Recreation Area, it may be seen in the shallow lakes between Hause and the Horsfall area. Kunze (1994) described this association.

CREeping SPIKERUSH SEASONALLY FLOODED HERBACEOUS ALLIANCE

ELPA3-JUNE

CREeping SPIKERUSH-NEVADA RUSH HERBACEOUS VEGETATION

leiocharis palustris-*Juncus nevadensis*



ELPA3-JUNE
(Sampled: 11 recon plots,
30 transect plots)
MW9102

Environment. The creeping spikerush-Nevada rush association appears to occur at the upper limit of brackish water on deflation plains, or in dune hollows. It is primarily a freshwater association, but tolerant of limited saline intrusion from spray or storm surges. Infilling by drifting sand creates complex microtopography, hydrology and salinity gradients. Stands may be flooded seasonally or year-round. The substrate is sand or mud, with 0-55 percent exposed.

Vegetation and ecology. The shrub layer is sparse, dominated by Hooker willow with 0-20 percent cover. Stands are predominantly herbaceous, averaging 68 percent cover, with high species diversity (Table 5). High species diversity is correlated with high light levels, areas of bare sand available for seasonal colonization by annuals and biennials, and a seasonally-fluctuating water regime that allows for favorable germination and establishment. Complex microtopographic, hydrologic and salinity gradients make species composition variable, and intergradation with adjoining associations is common. Dominant species are creeping spikerush, lilaeopsis and Nevada rush, but some of these may not be present in every plot. Moss cover ranges from 0-60 percent.

Succession. Early seral. Based on the inclusion of species typical of brackish marshes, such as lilaeopsis, three-square bulrush and saltgrass, the association probably replaces the Baltic rush-Pacific silverweed association. It is replaced by either the slough sedge-Pacific silverweed association, or the bog blueberry/slough sedge association.

Distribution and history. This association has been reported from the coasts of Oregon and Washington. Good examples may be seen in the deflation plain along the South Jetty road. It is common along most of the coastal dune sheets.

Management. Stands drying out by midsummer may be damaged by off-road vehicles.

Other studies. This association is distinct from the nearly monotypic creeping spikerush associations described in the literature. Egler (1934) described a rush association composed of five phases determined by moisture gradients and the duration on winter flooding. Wiedemann (1966, 1990) and Wiedemann et al. (1969) included this association in a broader concept of a "rush meadow" association dominated by Nevada rush, sickle-leaved rush and spring-bank clover. Kunze (1994) described a similar sickle-leaved rush-Nevada rush association from the coast of Washington.

Common plants of the creeping spikerush-Nevada rush association (n = 11 recon plots).

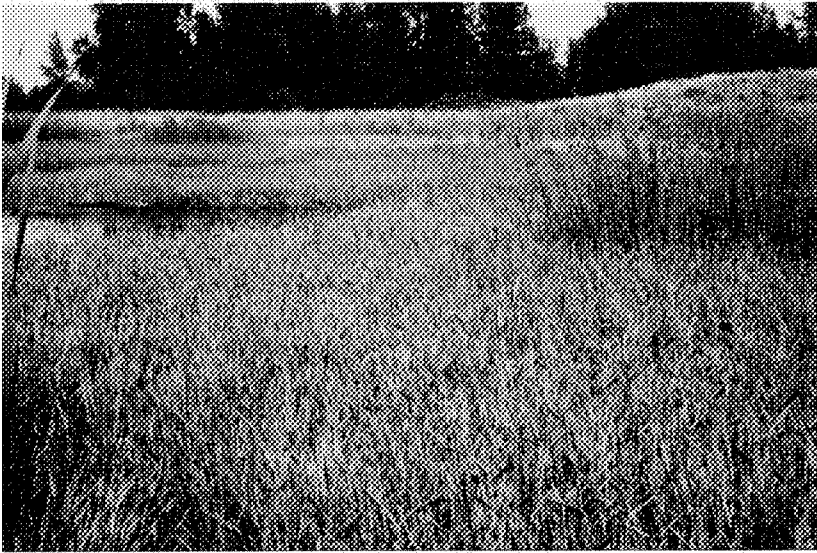
	Const.	Ave. cov. (%)	Range cov. (%)
SHRUBS AND WOODY GROUNDCOVER			
Hooker willow	73	3	0-20
HERBS, FERNS AND GRAMINOIDS			
Creeping spikerush	91	29	0-80
Lilaeopsis	91	14	0-40
Nevada rush	82	22	0-50
Pacific silverweed	82	3	0-10
Shore sedge	73	11	0-40
Slough sedge	73	3	0-10
Creeping buttercup	64	9	0-40
Salt rush	64	2	0-10
Sickle-leaved rush	55	8	0-40

KNOTGRASS SEASONALLY FLOODED HERBACEOUS ALLIANCE

PADI6

KNOTGRASS HERBACEOUS VEGETATION

Paspalum distichum



PADI6
(Not sampled)
WL9004

This early seral association was seen on the Recreation Area but not sampled. It is composed of nearly monotypic stands of knotgrass, occurring on mud and sand flats. Stands are flooded seasonally, but dry out in summer, although the water table is never far below the surface of the ground. Cover ranges from 30-80 percent. Knotgrass occurs occasionally along the coast, but the knotgrass association is more typical of the interior valleys of western Oregon and Washington. A single stand was observed on the floodplain of Tenmile Creek, where it may have been introduced by waterfowl. Kunze (1994) described this association.

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ARDSTEM BULRUSH SEASONALLY FLOODED HERBACEOUS ALLIANCE

SCACA

ARDSTEM BULRUSH HERBACEOUS VEGETATION

Phoenoplectus acutus var. *acutus*



SCACA
(Sampled: 1 recon plot)
MT8101

Environment. This emergent wetland association occurs around the margins of lakes and ponds on old deflation plains, in the dunes, and at the upper edge of brackish estuaries. The substrate may be sand, silt, mud or fibrous peat. Stands can be flooded year-round, flooded seasonally, or flooded diurnally in fresh or brackish tidal cycles. Stands can tolerate seasonal drying, but the substrate always remains wet. Water depth in flooded stands typically ranges from 1-2 feet.

Vegetation and ecology. In the single plot sampled on the Recreation Area, the stand was somewhat transitional, containing elements of associations on both sides of the hydrologic gradient. Douglas spiraea and bog blueberry were present in small amounts, as was pond lily. It is more typical to see stands of ardstem bulrush with a sparse to moderately rich herb layer, with no woody species present. In plots sampled elsewhere along the coast (J.A. Christy, unpublished data), cover of ardstem bulrush ranges from 20-60 percent, with much of the remaining cover composed of herbs and previous years' bulrush litter. Total herb cover, exclusive of bulrush, ranges from 0-50 percent, with the lowest values occurring in permanently-flooded stands. Floating-leaved pondweed and water-shield are frequent in flooded sites. Lady fern, cattail, small-fruited bulrush, and Pacific silverweed may be present in sites that dry out seasonally. Cover of individual species ranges from 1-5 percent. The surface layer is typically covered with litter from the previous year's stand of bulrush, unless the site has been burned.

Succession. Early seral. This type is preceded by associations occurring in deeper water. On the Recreation Area, these include the pond lily and the floating-leaved pondweed associations. Stands are usually replaced by the slough sedge association or the Douglas spiraea association.

Distribution and history. This association is common along the coast between northern California and British Columbia. On the Recreation Area, examples may be seen in Loon Lake, the northern end of Threemile Lake, and along North Slough. The occurrence along North Slough may be an artifact of railroad construction, which cut off part of the slough from direct tidal influence, increasing the influence of fresh water west of the tracks. This species has also been called *Scirpus acutus*.

Management. No special management is needed to maintain this association, other than maintenance of water levels. Stands are too wet for recreational use. Groundwater pumping at the southern end of the Recreation Area may be affecting the water table in that area. While hardstem bulrush can survive seasonal exposure of its roots when ponds dry up in late summer, it may not survive extended exposure caused by premature drawdown of lake levels. Diversity of aquatic species will undoubtedly be diminished if pumping is really affecting water tables.

Other studies. Jefferson (1975) and Macdonald (1977) described a bulrush association in brackish marshes, and Thomas (1980) and Kunze (1994) described freshwater occurrences. Hardstem bulrush is frequently misidentified as softstem bulrush, which apparently does not occur in brackish water, and is generally absent from coastal areas. The bulrush series of Sawyer and Keeler-Wolf (1995) includes this association.

Common plants of the hardstem bulrush association (n = 1 recon plot).

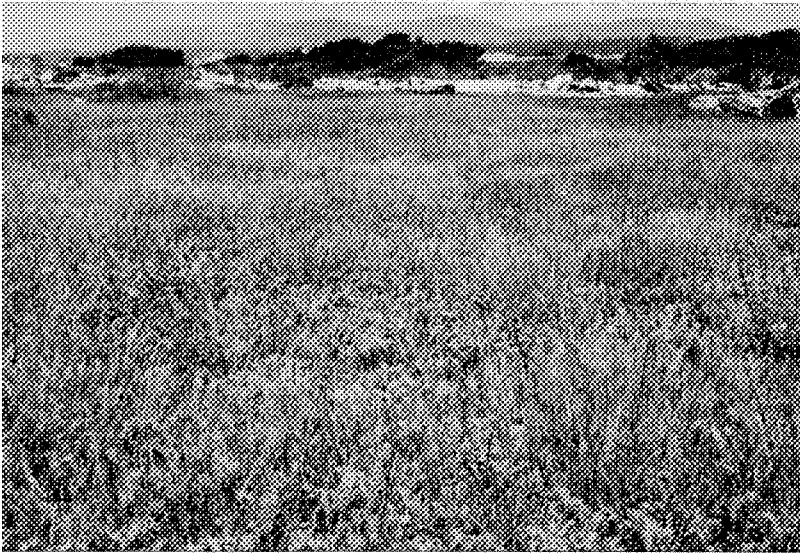
	Const.	Ave. cov. (%)	Range cov. (%)
SHRUBS AND WOODY GROUNDCOVER			
Bog blueberry	100	1	1
Douglas spiraea	100	1	1
HERBS, FERNS AND GRAMINOIDS			
Hardstem bulrush	100	60	60
Water smartweed	100	15	15
Pond lily	100	2	2

CREeping BENTGRASS TIDAL HERBACEOUS ALLIANCE

AGSTS-AREGE

CREeping BENTGRASS-PACIFIC SILVERWEED TIDAL HERBACEOUS VEGETATION

grostis stolonifera-*Argentina egedii*



AGSTS-AREGE
(Sampled: 1 recon plot)
WE0106

Environment. This association is restricted to brackish areas in estuaries and deflation plains. Topography is flat to slightly undulating, and the substrate is sand. Salinity originates from irregular storm surges and extreme high tides in areas adjacent to salt or brackish water. Drift logs are usually present.

Vegetation and ecology. This common salt marsh association is not well represented on the Recreation Area, because of the relative scarcity of suitable sites. Vegetation in the single plot sampled was dominated by Pacific silverweed and creeping bentgrass, with 70 and 30 percent cover, respectively. Total cover was nearly 100 percent. In plots sampled elsewhere along the coast, creeping bentgrass has been reported with cover as high as 95 percent (Taylor and Frenkel 1979; Taylor 1980). Undulating topography and slight changes in elevation create a variety of salinity gradients, and composition varies locally. Creeping bentgrass is a Eurasian species, but is so widely distributed that many people have assumed it to be native. How it has impacted native salt marsh associations is unknown. It may have colonized relatively bare mud flats, or it may have displaced native species.

Succession. Early seral. Based on topographic position and a small component of saltgrass, this association appears to replace the saline saltgrass-Pacific silverweed association, and is subsequently replaced in turn by the less saline Lyngby sedge-Pacific silverweed association.

Distribution and history. This association is common in salt marshes along the coast between northern California and southeastern Alaska. On the Recreation Area, stands were seen in the Tenmile and Siltcoos estuaries, in North Slough, and at the extreme northern end of the South Jetty. This association is not common on the Recreation Area, because so little estuarine area is present. Creeping bentgrass has also been called *Agrostis alba*, and Pacific silverweed has been called *Potentilla pacifica*. Creeping bentgrass is thought to have been introduced from Europe.

Management. Methods for eradicating creeping bentgrass in estuaries have not been studied. On the Recreation Area, off-road vehicles should be excluded from sensitive estuarine areas.

Other studies. Taylor and Frenkel (1979), Taylor (1980), Thomas (1980), Mitchell (1981), Thomas (1984), Frenkel and Boss (1988) and Frenkel and Morlan (1990) all described various expressions of this association. Duebendorfer (1992) included this species in his "brackish marsh" association.

Common plants of the creeping bentgrass-Pacific silverweed association (n = 1 recon plot).

	Const.	Ave. cov. (%)	Range cov. (%)
HERBS, FERNS AND GRAMINOIDS			
Pacific silverweed	100	70	70
Creeping bentgrass	100	30	30
Saltgrass	100	4	4
Salt rush	100	3	3
Lyngby sedge	100	2	2
Tufted hairgrass	100	1	1
Gumweed	100	1	1
Slough sedge	100	1	1

LYNGBY SEDGE TIDAL HERBACEOUS ALLIANCE

CALY3-AREGE

LYNGBY SEDGE-PACIFIC SILVERWEED TIDAL HERBACEOUS VEGETATION

Lyngby sedge-Argentina egedii



CALY3-AREGE

(Sampled: 4 recon plots)

WE0105

Environment. This association is restricted to brackish marshes in estuaries and deflation plains adjacent to estuaries. Stands in estuaries occur at low to middle topographic position, in and just above the intertidal zone, where mud flats are cut by numerous tidal streams and are free of sand burial. The substrate is sand and mud, with 0-25 percent exposed at low tide. Stands on deflation plains are not subject to tidal influence, but occasional storm surges flood these areas with seawater, reworking sediments and importing large drift logs from beaches. Exposed sand and mud may have saline or algal crusts when dry.

Vegetation and ecology. Stands are exclusively herbaceous, with 75-90 percent cover by graminoids, and 10-30 percent cover by herbs. Species diversity is low. Dominant species are Lyngby sedge with 5-90 percent cover, and Pacific silverweed with 10-25 percent cover. Other species present in small mounts are those belonging to associations with either greater or lesser salt tolerance, occurring either below or above this association's elevation in the salt marsh. Stands intergrade with freshwater associations with increasing distance from estuaries. Because of their small size, most estuaries on the Recreation Area probably have had a history of variable salinity and freshwater mixing, with associated shrinking and expansion of salt-tolerant associations.

Succession. Early seral. Stands of this type are preceded by brackish-water associations of the intertidal zone. On the Recreation Area, are the creeping bentgrass-Pacific silverweed, and three-square bulrush associations. As infilling by sediments occurs, this association is replaced by the slightly drier Baltic sedge-Pacific silverweed association.

Distribution and history. This association is common in estuaries along the coast between northern California and Alaska. Its occurrence in the Recreation Area is limited because few rivers and mud flats occur within the administrative boundaries, and because sand burial is pervasive. The best examples may be seen along North Slough in Coos Bay, on the Umpqua Spit, at the north end of South Jetty, and

in the small estuaries of Tenmile Creek and Siltcoos River. Hydrology in the marshes of North Slough has been disturbed by drainage ditches and the railroad bed. The estuaries were grazed by livestock earlier in this century. Pacific silverweed has also been called *Potentilla pacifica*.

Management. The estuaries of Tenmile Creek and Siltcoos River receive moderately high recreational use for wildlife viewing and hiking. Recreation pressure is highest at Siltcoos River because it is so easily accessible. Shifting sands at the mouth of these small estuaries create changeable conditions for tidal inundation and salt intrusion, making management of salt marsh difficult in these areas. Mechanical removal of sand at the mouth of the river would allow more penetration of salt into the estuaries, if such management becomes necessary.

Other studies. Frenkel and Morlan (1990), Viereck et al. (1992), Shephard (1995), and Thilenius (1995) described this association.

Common plants of the Lyngby sedge-Pacific silverweed association (n = 4 recon plots).

	Const.	Ave. cov. (%)	Range cov. (%)
HERBS, FERNS AND GRAMINOIDS			
Lyngby sedge	100	68	45-90
Pacific silverweed	100	15	10-25
Tufted hairgrass	75	8	0-30
Saltgrass	75	4	0-10
Spring-bank clover	50	3	0-10
Three-square bulrush	50	2	0-4
Creeping spikerush	50	1	0-1
Salt rush	50	1	0-1

TUFTED HAIRGRASS TIDAL HERBACEOUS ALLIANCE

DECEC-AREGE

TUFTED HAIRGRASS-PACIFIC SILVERWEED TIDAL HERBACEOUS VEGETATION

Deschampsia cespitosa ssp. *cespitosa*-*Argentina egedii*



DECEC-AREGE
(Not sampled)
WE0104

This early seral association was seen on the Recreation Area, but never sampled. It occurs in high salt marsh, with intermittent tidal flooding. In plots sampled elsewhere along the coast (Jefferson 1975; Frenkel et al. 1978), tufted hairgrass ranges from 20-50 percent cover, and Pacific silverweed has 30-60 percent cover. This association occurs in estuaries along the coast between southwestern Oregon and Alaska, becoming more common north of Tillamook Bay, Oregon. It is not extensive on the Recreation Area, because estuarine habitat is limited, and the association is near the southern end of its range. A single stand was seen in the Tenmile Creek estuary. Jefferson (1975), Stout (1976), Macdonald (1977), Frenkel et al. (1978), and Boggs (1997) described this association. Pacific silverweed has also been called *Potentilla pacifica*.

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SALTGRASS-PACIFIC SILVERWEED TIDAL HERBACEOUS VEGETATION

Distichlis spicata-*Argentina egedii*



DISP-AREGE

(Sampled: 6 recon plots)

WE0107

Environment. This is the most salt-tolerant association present on the Recreation Area, and also one of the most limited in distribution. Although it is common in large estuaries elsewhere along the coast, the small estuaries of the Recreation Area are largely unsuitable for its formation, because of limitations in size and variable salinities. The association occurs on sand or mud in slight depressions in deflation plains adjacent to estuaries, usually cut with channels of tidal creeks. Ten to fifty percent of the substrate may be exposed. Occasional storm surges flood these areas with seawater, reworking sediments and importing large drift logs from beaches.

Vegetation and ecology. Trees and shrubs are absent. Stands sampled were dominated by graminoids with 85-95 percent cover. Cover may be as low as 40-50 percent in salt pannes. Herb content ranges from 1-15 percent cover. Abandoned tidal channels may contain salt pannes, depressions where seawater from extreme high tides or storms becomes stranded and evaporates, creating highly saline soils and algal crusts tolerated by only a few species of vascular plants. These are the most saline habitats on the Recreation Area. Because microtopography and salinity gradients are complex, composition is variable, and not all components are always present. On the Recreation Area, the dominant species at these sites is saltgrass, with 60-90 percent cover. Pickleweed, shadscale, arrowgrass and fleshy jaumea, typical components of this association elsewhere along the coast, occur here only sporadically, usually only in salt pannes. Pickleweed and arrowgrass may be present in small amounts, although they were absent from our plots. Pacific silverweed may be codominant, but is not always present. Lyngby sedge and three-square bulrush intergrade from lower-elevation brackish marsh, while Baltic rush, colonial bentgrass and tufted hairgrass intergrade from higher-elevation brackish marsh. Sites may be obliterated by storms or sedimentation.

Succession. Early seral. This is one of the first associations of vascular plants to appear on tidal mudflats in the Recreation Area. It colonizes areas dominated by algae. Stands are replaced by the creeping bentgrass-Pacific silverweed association on slightly higher topography.

Distribution and history. This association is common in salt marshes along the coast from northern California to British Columbia. On the Recreation Area, it is restricted to North Slough, the estuaries of Tenmile Creek and Siltcoos River, and the extreme northern end of the South Jetty peninsula, in the estuary of the Siuslaw River. It may also occur on the Umpqua Spit south of Threemile Creek. Saltgrass has also been called *Distichlis stricta*, and Pacific silverweed has been called *Potentilla pacifica*.

Management. When salt pannes dry out in summer, they may be vulnerable to damage by off-road vehicles. Shifting sands at the mouth of the small estuaries create changeable conditions for tidal inundation, making management of salt marsh unpredictable.

Other studies. This association and its many variations have been documented by Thum (1972), Jefferson (1975), Stout (1976), Macdonald (1977), Frenkel et al. (1978), Taylor and Frenkel (1979), Taylor (1980), Mitchell (1981), Frenkel et al. (1981), Liverman (1982), Frenkel and Boss (1988), Newton (1989), Frenkel and Morlan (1990), and Peinado et al. (1994). Wiedemann (1984) described a creeping spikerush-saltgrass association from deflation plains, where ocean water occasionally surges over foredunes. Duebendorfer (1992) described a similar "salt marsh" association dominated by saltgrass, pickleweed and arrowgrass. The saltgrass series of Sawyer and Keeler-Wolf (1995) includes this association.

Common plants of the saltgrass-Pacific silverweed association (n = 6 recon plots).

	Const.	Ave. cov. (%)	Range cov. (%)
HERBS, FERNS AND GRAMINOIDS			
Saltgrass	100	73	60-90
Pacific silverweed	100	12	Tr-45
Lyngby sedge	83	12	0-45
Three-square bulrush	50	8	0-40
Salt rush	50	1	0-2
Spring-bank clover	50	1	0-1
Shadscale	50	1	0-1
Baltic rush	33	3	0-15
Colonial bentgrass	33	1	0-5
Creeping spikerush	33	1	0-3
Tufted hairgrass	33	1	0-2
Sea milkwort	17	3	0-15
Lilaeopsis	17	3	0-15
Pickleweed	17	1	0-7
Creeping buttercup	17	1	0-5
Slough sedge	17	1	0-3
Seaside arrowgrass	17	Tr	0-2
Meadow barley	17	Tr	0-1
Graceful arrowgrass	17	Tr	0-1
Brass buttons	17	Tr	0-1

BALTIC RUSH-PACIFIC SILVERWEED TIDAL HERBACEOUS VEGETATION

uncus balticus-Argentina egedii



JUBA-AREGE
(Sampled: 1 recon plot)
WE0102

Environment. This association is a component of "salt meadow" vegetation occurring just above the intertidal zone in salt marshes, where limited freshwater influence is present. On the Recreation Area, it is restricted to brackish marshes in estuaries and deflation plains adjacent to estuaries. Stands in estuaries occur at middle to upper topographic position, above the intertidal zone, where they may be inundated occasionally by extreme high tides. The substrate is sand and mud. Stands on deflation plains are not subject to tidal influence, but occasional storm surges flood these areas with seawater, reworking fine sediments, and importation of large drift logs from beaches.

Vegetation and ecology. Only one plot was sampled on the Recreation Area, but it is similar to other stands sampled elsewhere along the coast. Tree and shrub layers are absent. The herb layer is species-poor (Table 5), but total vegetative cover is nearly 100 percent. It is dominated by Baltic rush with 40-60 percent cover, and Pacific silverweed with 25-60 percent cover. Lyngby sedge, tufted hairgrass and colonial bentgrass may be conspicuous or even codominant in some stands. Species from intergrading low salt marsh include pickleweed, arrowgrass and lilaeopsis.

Succession. Early seral. Associations preceding this are those of more saline conditions in the intertidal zone. On the Recreation Area, it replaces the Lyngby sedge-Pacific silverweed association. In freshwater conditions, it is in turn replaced by the creeping spikerush-Nevada rush association. If sand infiltration occurs, making sites slightly drier, stands convert to the sickle-leaved rush-salt rush association.

Distribution and history. This association is common in salt marshes along the coast from northern California to Washington. On the Recreation Area, occurrences are limited because of the lack of suitable habitat. Small examples occur along North Slough in Coos Bay, on the Umpqua Spit and in the estuaries of Tenmile Creek and Siltcoos River. Pacific silverweed has also been called *Potentilla pacifica*.

Management. Stands are small and no recreation conflicts were noted in the field. Off-road vehicles could threaten some stands if estuary areas become accessible to these vehicles.

Other studies. Frenkel et al. (1978), Mitchell (1981), Frenkel et al. (1981), Frenkel and Boss (1988), and Frenkel and Morlan (1990) described this association.

Common plants of the Baltic rush-Pacific silverweed association (n = 1 recon plot).

	Const.	Ave. cov. (%)	Range cov. (%)
HERBS, FERNS AND GRAMINOIDS			
Pacific silverweed	100	60	60
Baltic rush	100	40	40
Saltgrass	100	25	25
Lyngby sedge	100	2	2
Tufted hairgrass	100	1	1
Tall fescue	100	1	1
Gumweed	100	1	1
Pickleweed	100	1	1

THREE-SQUARE BULRUSH TIDAL HERBACEOUS ALLIANCE

SCAM6

THREE-SQUARE BULRUSH TIDAL HERBACEOUS VEGETATION

Schoenoplectus americanus



SCAM6

(Sampled: 3 recon plots)

WE0101

Environment. This association occurs primarily in brackish marshes in estuaries, and deflation plains adjacent to estuaries. Stands in estuaries grow at low to middle elevations, in and just above the intertidal zone, where mud flats may be cut by numerous tidal streams and are free of sand burial. The substrate is sand and mud, with 30-70 percent exposed, or coated with a saline or algal crust when dry. Stands on deflation plains are not subject to tidal influence, but flooding in winter and drying in summer. Occasional storm surges cause extensive flooding of these areas by seawater, reworking sediments and importing large drift logs from beaches.

Vegetation and ecology. Woody species are absent where this association occurs in estuaries, but hooker willow may be present occasionally among stands of three-square bulrush on deflation plains. Total herb cover may range from 1-98 percent. It is dominated by three-square bulrush with cover ranging from 25-90 percent. Other species frequently present include Lyngby sedge, Pacific silverweed and lilaeopsis, with covers ranging from 5-40 percent each. The most brackish sites often contain arrowgrass and saltgrass. Three-square bulrush usually occurs on wetter sites than saltgrass, but it is much more tolerant of fresh water than is saltgrass. Stands on deflation plains frequently intergrade with other associations in response to microtopography and salinity gradients.

Succession. Early seral. Three-square bulrush may be the first vegetation to develop on sediments in the intertidal zone. Depending on microsite and salinity gradients, it is replaced by the Lyngby sedge-Pacific silverweed association.

Distribution and history. This association is common in estuaries along the coast between northern California and British Columbia. Its occurrence in the Recreation Area is limited, because so little habitat occurs within the administrative boundaries, and because sand burial is so pervasive. The best examples may be seen along North Slough in Coos Bay, on the Umpqua Spit, at the northern end of South Jetty, and in the estuaries of Tenmile Creek and Siltcoos River. Hydrology in the marshes of

North Slough has been disturbed by drainage ditches and the railroad bed. The estuaries may have been grazed earlier in this century. This species has also been called *Scirpus americanus*.

Management. The estuaries of Tenmile Creek and Siltcoos River receive moderately high use for wildlife viewing and hiking. Recreation pressure is greatest at Siltcoos River because it is so easily accessible. Shifting sands at the mouth of these estuaries create changeable conditions for tidal inundation, making management of salt marsh unpredictable. Off-road vehicles may churn up some sites when water levels drop in summer.

Other studies. Jefferson (1975), Stout (1976), Macdonald (1977), Frenkel et al. (1978) and Liverman (1982) described this association in brackish marshes. Thomas (1980, 1984) and Kunze (1994) described its occurrence in brackish marshes with greater freshwater influence. The bulrush series of Sawyer and Keeler-Wolf (1995) includes this association.

Common plants of the three-square bulrush association (n = 3 recon plots).

	Const.	Ave. cov. (%)	Range cov. (%)
SHRUBS AND WOODY GROUNDCOVER			
Hooker willow	67	2	3
HERBS, FERNS AND GRAMINOIDES			
Three-square bulrush	100	45	25-65
Creeping spikerush	100	12	1-20
Pacific silverweed	100	10	1-20
Slough sedge	67	15	0-30
Lilaeopsis	67	2	0-5
Lyngby sedge	33	5	0-15
Saltgrass	33	1	0-2

SEASHORE LUPINE HERBACEOUS VEGETATION

Lupinus littoralis



LULI2

(Sampled: 4 recon plots,
54 transect plots)
GR8212

Environment. This association is characteristic of open, dry, sparsely-vegetated dunes, and to a lesser extent dry deflation plains. The substrate is sand with little or no organic material. Sand movement is moderate to slight, causing both erosion and burial of stands. Insolation is intense, and summer drought is pervasive. Many populations of seashore lupine become established during the summer on dune surfaces recently created by winter winds. The subsequent return of winter wind patterns often obliterates these newly-established populations.

Vegetation and ecology. Bare sand averages 51 percent and ranges from 5-97 percent. Tree and shrub layers are absent. The herb layer is depauperate to moderately diverse, with total cover averaging 39 percent, ranging from 3-75 percent. The dominant species is seashore lupine, with cover ranging from 3-75 percent, averaging 31 percent. The plots sampled had been invaded by European beachgrass, and many stands are being replaced by it throughout the Recreation Area. Other native components present in lesser numbers include species typical of open dunes, such as seashore bluegrass, red fescue, beach silvertop, coast strawberry, beach knotweed and yellow sandverbena. Some of these species form plant associations of their own, and sometimes intergrade with one another. Seashore lupine reproduces prolifically by seed, and can colonize bare dune surfaces readily.

Succession. Early seral. The seashore lupine association develops on bare sand where the movement of sand diminishes, sometimes only seasonally. On open dunes, in the absence of European beachgrass, it is replaced by the red fescue association. Where sand movement is reactivated, it is replaced by the European beachgrass association.

Distribution and history. This association occurs along the coast between southwestern Oregon and British Columbia. On the Recreation Area, it occurs in most places where there is open sand with somewhat reduced sand movement. Although many older stands are being overrun by European beachgrass, new stands are ubiquitous, and the species is prolific.

Management. This association is adapted to ongoing disturbance from shifting sands. Recreational activities may have local influence, but no long-term problems are apparent.

Other studies. Egler (1934) described a seashore bluegrass-seashore lupine association. Wiedemann (1966) and Wiedemann et al. (1969) included seashore lupine as part of a "dry meadow" association. Kunze (1983, 1985) described a seashore lupine-seashore bluegrass-coast strawberry association from dry deflation plains.

Common plants of the seashore lupine association (n = 4 recon plots).

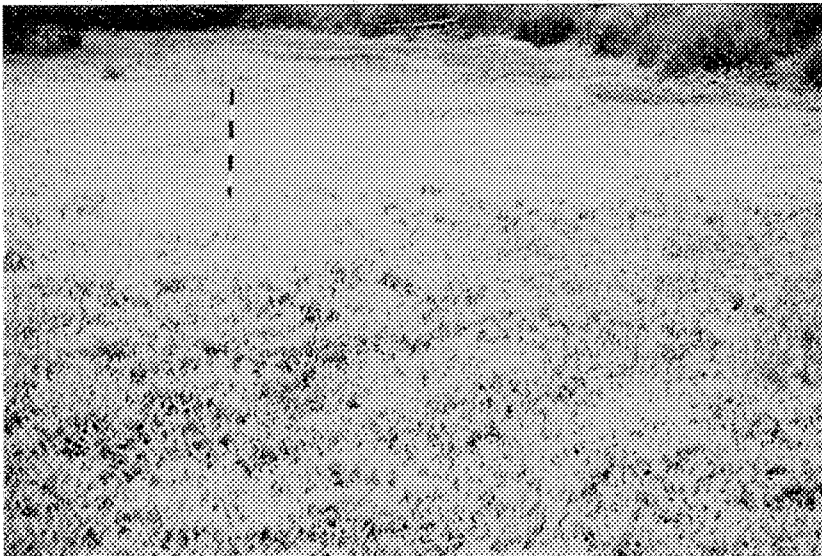
	Const.	Ave. cov. (%)	Range cov. (%)
HERBS, FERNS AND GRAMINOIDS			
Seashore lupine	100	31	3-75
European beachgrass	100	10	1-25
Seashore bluegrass	100	6	1-10
Red fescue	75	2	0-5
False dandelion	50	3	0-10
Silver hairgrass	50	1	0-1
Beach silvertop	50	1	0-1
Little hairgrass	50	Tr	0-1

WATERPEPPER SEASONALLY FLOODED HERBACEOUS ALLIANCE

POHY2-LUPA

WATERPEPPER- WATER PURSLANE HERBACEOUS VEGETATION

Polygonum hydropiperoides-Ludwigia palustris



POHY2-LUPA
(Not sampled)
WL9001

This early seral association was seen on the Recreation Area, but never sampled. It forms extensive stands in shallow lakes, as well as ponds on deflation plains, subject to drying in summer. The substrate is mud. Cover of waterpepper ranges from 25-95 percent, while cover of water purslane varies from 5-80 percent. The association is more typical of interior valleys in Oregon and Washington, but it occurs sporadically along the coast from southwestern Oregon to southwestern Washington. On the Recreation Area, it was seen on the floodplain of Tenmile Creek, and in the Lagoon area of Siltcoos River. Kunze (1994) described this association.

FLOATING WATER-PENNYWORT SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE

HYRA

FLOATING WATER-PENNYWORT HERBACEOUS VEGETATION

Hydrocotyl ranunculoides



HYRA
(Not sampled)
WL0102

This early seral association was seen on the Recreation Area, but never sampled. It forms nearly nonotypic stands that may cover the entire surface of shallow lakes, ponds, and pools in peatlands. Cover ranges from 60-95 percent. The association occurs along the coast between southwestern Oregon and southwestern Washington. It was seen once on the Recreation Area, where it forms extensive mats covering the surface of an unnamed lake just west of the railroad tracks along North Slough. This is the largest occurrence of its type known in the Pacific Northwest. It apparently has not been described before.

WATER SMARTWEED SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE

POAM8

WATER SMARTWEED HERBACEOUS VEGETATION

Polygonum amphibium



POAM8
(Not sampled)
WL9002

This early seral association was seen on the Recreation Area, but never sampled. It forms aquatic beds in lakes and ponds, where it may form extensive and sometimes dense floating mats. It also tolerates seasonal drying. Stands sampled elsewhere are usually monotypic, with 30-95 percent cover (Kunze 1994). This association is more common in the interior valleys of Oregon and Washington. On the Recreation Area, this association was seen along Tenmile Creek, Tahkenitch Creek, and in the Lagoon area along the Siltcoos River. Kunze (1994) described this association.

POND LILY SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE

NULUP

POND LILY HERBACEOUS VEGETATION

Nuphar lutea ssp. *polysepala*



NULUP

(Sampled: 1 recon plot)

WL0101

Environment. This aquatic association is common in lakes and ponds occurring on deflation plains, floodplains, and along the edge of the dune sheet. Water is usually permanent, but may dry up in late summer, revealing the enormous fleshy rhizomes of pond lily. The substrate is muck.

Vegetation and ecology. The single plot sampled on the Recreation Area is typical of stands seen elsewhere along the coast. Small trees and Hooker willow, Sitka willow, or Douglas spiraea frequently occur around the lake margins or on emergent logs and small islands. The herb layer is dominated by beds of pond lily with 15-30 percent cover, the leaves floating on the surface or protruding 1-2 feet above the surface of the water. Stands are clonal, and may cover extensive areas in shallow lakes. They often intermix with other aquatic bed associations, such as those dominated by floating-leaved pondweed and water-shield. Bog buckbean, a clonal aquatic bed species more typical of montane mires and lakes, occurs with pond lily in Beale Lake. Graminoids, including northern mannagrass, threeway sedge, inflated sedge and slough sedge, may occur with total cover seldom greater than 5 percent. They are restricted to shallows or emergent substrates. Common bladderwort, an insectivorous species, is a frequent associate.

Succession. Early seral. The pond lily association is one of several aquatic bed associations that initiate transition from lacustrine habitats to palustrine habitats. It is preceded by benthic associations in deeper water, such as coontail, waterweed, or common bladderwort. Pond lily needs an accumulation of littoral sediments or organic material to create shallows suitable for growth. As water depths and the period of seasonal inundation diminish, it is replaced on the Recreation Area by either the simplestem bur-reed, hardstem bulrush, or inflated sedge associations.

Distribution and history. This association is common along the coast between northern California and Alaska. On the Recreation Area, good examples may be seen in the shallow lakes between Beale Lake

and Horsfall Lake, between the south loop of Eel Creek campground and Highway 101, and in sheltered arms of Tahkenitch Lake. This species has also been called *Nuphar polysepalum*.

Management. No special management is needed to maintain this association, other than maintenance of water levels. Groundwater pumping at the southern end of the Recreation Area may be affecting the water table in that area. Like floating-leaved pondweed, pond lily can survive seasonal exposure of its roots when ponds dry up in late summer, but it may not survive extended exposure caused by premature drawdown of lake levels. Diversity of all aquatic species in the Horsfall area will decline if pumping is really lowering the water table.

Other studies. Peck (1919) and Egler (1934) described pond lily associations in lakes and ponds along the coast of Oregon. Viereck et al. (1992), Kunze (1994), Shephard (1995) and Boggs (1998) described this association. The yellow pond-lily series of Sawyer and Keeler-Wolf (1995) includes this association.

Common plants of the pond lily association (n = 1 recon plot).

	Const.	Ave. cov. (%)	Range cov. (%)
SHRUBS AND WOODY GROUNDCOVER			
Douglas spiraea	100	1	1
HERBS, FERNS AND GRAMINOIDS			
Pond lily	100	20	20
Water clubrush	100	5	5
Inflated sedge	100	2	2
Threeway sedge	100	2	2
Northern mannagrass	100	2	2
Floating-leaved pondweed	100	1	1

FLOATING-LEAVED PONDWEED SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE

PONA4

FLOATING-LEAVED PONDWEED HERBACEOUS VEGETATION

Potamogeton natans



PONA4

(Sampled: 1 recon plot)

WL0103

Environment. This aquatic bed association occurs around the margins of lakes and ponds on old deflation plains, among the dunes, and particularly on larger dune-blocked lakes along the east edge of the dune sheet. The substrate may be sand, silt, mud or fibrous peat. Stands are usually flooded year-round, but can tolerate seasonal drying if the substrate remains wet. Water depth in flooded stands typically ranges from 1-6 feet.

Vegetation and ecology. This association is best expressed in monotypic stands occurring on the surfaces of lakes and ponds. Frequently, it intermixes with adjoining associations, and many ecologists have sampled these mixed stands rather than the monotypic stands. The single stand sampled on the Recreation Area occurred on a deflation plain, and had inclusions of emergent marsh species. Woody layers are absent. Total herb cover ranges from 20-85 percent, dominated by floating-leaved pondweed with cover from 20-70 percent. Other species frequently present are pond lily, water-shield, common ladderwort and hardstem bulrush.

Succession. Early seral. This floating-leaved association is preceded by benthic associations in deeper water, such as coontail, waterweed, or common bladderwort. On the Recreation Area, infilling of sediments in the littoral area leads to replacement of this association by either the hardstem bulrush, inflated sedge, or simplestem bur-reed associations.

Distribution and history. This association is common along the coast between northern California and Alaska. On the Recreation Area, good examples may be seen in the shallow lakes between Beale Lake and Horsfall Lake, and in sheltered arms of Tahkenitch Lake.

Management. No special management is needed to maintain this association, other than maintenance of water levels. Stands are too wet for recreational use. Groundwater pumping at the southern end of the Recreation Area may be affecting the water table in that area. Like pond lily, floating-leaved pondweed can survive seasonal exposure of its roots when ponds dry up in late summer, but it may not survive extended exposure caused by premature drawdown of lake levels. Diversity of all aquatic species in the Horsfall area will decline if pumping is really lowering the water table.

Other studies. Peck (1919) described a colony of floating-leaved pondweed, similar to those occurring elsewhere on the coast. This association was described by Kunze (1994) and Boggs (1998), and is included in the "pondweeds with floating leaves" series of Sawyer and Keeler-Wolf (1995).

Common plants of the floating-leaved pondweed association (n = 1 recon plot).

	Const.	Ave. cov. (%)	Range cov. (%)
HERBS, FERNS AND GRAMINOIDS			
Floating-leaved pondweed	100	60	60
Simplestem bur-reed	100	35	35
Creeping spikerush	100	5	5
Horsetail	100	2	2
Marsh speedwell	100	1	1
Pacific silverweed	100	1	1

IMPLESTEM BUR-REED SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE

SPAN2

IMPLESTEM BUR-REED HERBACEOUS VEGETATION

Spartanium angustifolium



SPAN2

(Sampled: 1 recon plot)

WL0104

Environment. This association occurs in freshwater emergent marshes, on deflation plains and around the margins of lakes and ponds further inland. Along larger tidal rivers, it forms marshes above the influence of brackish water. The substrate is peaty muck. Stands are seasonally or perennially flooded. Water levels may drop to expose the roots, but the substrate is always wet.

Vegetation and ecology. Only one stand was sampled on the Recreation Area, at the margin of a pond on a deflation plain. Woody layers were absent in the plot, but both Hooker willow and Douglas spiraea were present around the margins, with an average height of 4 feet. Simplestem bur-reed dominated the herb layer, with 45 percent cover. Growth is clonal, the plants spreading by rhizomes. Slough sedge was present with 10 percent cover. Species from earlier seral stages, such as pond lily or floating-leaved pondweed, may be present. These sites are feeding areas for beaver.

Succession. Early seral. In the Recreation Area, this type is preceded by aquatic bed associations dominated by either floating-leaved pondweed or pond lily. Stands may be replaced by either the slough sedge or Douglas spiraea associations.

Distribution and history. This association is common along the coast between northern California and British Columbia, and it is also common inland. On the Recreation Area, stands can be seen south of Siltcoos estuary, in the Lagoon area of the Siltcoos River lagoon, along Tenmile Creek, and near Beale Lake. This species has also been called *Sparganium emersum*.

Management. Recreational impacts are minimal, because stands are too wet for casual entry. Maintenance of water supply and beaver populations will be adequate to sustain this association.

Other studies. Christy (1993), Christy and Putera (1993), and Kunze (1994) listed a similar association from freshwater intertidal areas on the lower Columbia River. Kunze (1994) also described a broad-fruited bur-reed association (*Sparganium eurycarpum*) with similar composition, hydrology and substrate, but this species has not been reported from the Recreation Area. The bur-reed series of Sawyer and Keeler-Wolf (1995) includes this association.

Common plants of the simplestem bur-reed association (n = 1 recon plot).

	Const.	Ave. cov. (%)	Range cov. (%)
HERBS, FERNS AND GRAMINOIDS			
Simplestem bur-reed	100	45	45
Slough sedge	100	10	10
Pacific silverweed	100	1	1
Marsh cinquefoil	100	1	1
Creeping spikerush	100	1	1

SOUTH AMERICAN WATERWEED PERMANENTLY FLOODED HERBACEOUS ALLIANCE

EGDE

SOUTH AMERICAN WATERWEED HERBACEOUS VEGETATION

Egeria densa

EGDE

(Not sampled)

WL0106

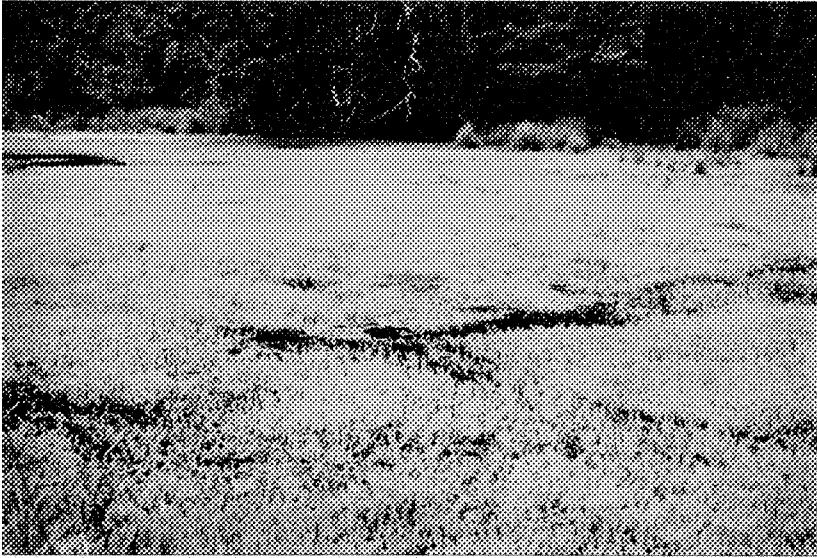
This early seral association was seen on the Recreation Area, but not sampled. Its old name is *Elodea densa*. It forms extensive monotypic beds of submersed, dark green to blackish shoots in lakes, ponds and streams. Cover ranges from 60-95 percent. Introduced for the aquarium trade, South American waterweed has escaped and spread throughout the Pacific Northwest, northward to British Columbia. It replaces the native Canadian waterweed, and populations often become dense enough to obstruct boat passage. On the Recreation Area, extensive stands may be seen in Siltcoos River, the adjacent Lagoon, and in Tahkenitch Creek along the Tahkenitch trail. Dispersal is accomplished by fragments adhering to recreational boats, and populations are almost always present in lakes that have boat ramps. This weedy association apparently has not been described before.

PARROT-FEATHER PERMANENTLY FLOODED HERBACEOUS ALLIANCE

MYAQ2

PARROT-FEATHER HERBACEOUS VEGETATION

Myriophyllum aquaticum



MYAQ2
(Not sampled)
WL0105

This early seral association was seen on the Recreation Area, but not sampled. Its old name is *Myriophyllum braziliensis*. Parrot-feather forms dense, monotypic beds of submerged and emergent, lime-green shoots on the surface of lakes, ponds and pools. Cover ranges from 40-95 percent. Introduced as an ornamental and for the aquarium trade, parrot-feather has escaped and is spreading aggressively throughout the Pacific Northwest (Sytsma and Anderson 1989). Beds may become so thick that they form floating mats used by waterfowl for nesting platforms, and they may also obstruct boat passage in lake channels. If left undisturbed, continued accumulation of biomass may develop floating mats of peat that support fen vegetation of sphagnum moss, sedges, shore pine and stunted Sitka spruce. In the Recreation Area, extensive beds of parrot-feather may be seen in the Lagoon area of Siltcoos River, as well as along the river itself. This weedy association apparently has not been described before.

COMMON BLADDERWORT PERMANENTLY FLOODED HERBACEOUS ALLIANCE

UTMA

COMMON BLADDERWORT HERBACEOUS VEGETATION

Utricularia macrorhiza

UTMA
(Not sampled)
WL0107

This early seral association was seen on the Recreation Area, but not sampled. It forms nearly monotypic beds, submerged in lakes and ponds. This large insectivorous species is characterized by its bladders blackened with the remains of aquatic invertebrates. Cover ranges from 40-95 percent. The association occurs in lakes and ponds throughout the Pacific Northwest. On the Recreation Area, good examples occur in the shallow lakes between Hauser and Horsfall. Boggs (1998) described this association in Alaska. This species has also been called *Utricularia vulgaris*.

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Appendix 1. Summary data for recon vegetation plots, Oregon Dunes National Recreation Area, by National Vegetation Classification System class and association. Minimum constancy = 0.10, minimum average cover = 0.10, Tr = < 1.0.

Site and vegetation variables for which data were collected in transect plots and recon plots.

Data Type	Transect plots	Recon Plots
Elevation (ft)	x	x
Aspect	x	x
Slope (°)	x	x
Landform (mapping units of Pinto et al. 1972)	x	
Macroposition (vertical, horizontal)	x	x
Microposition (vertical, horizontal)	x	x
Macrorelief (horizontal, vertical)	x	x
Microrelief (horizontal, vertical)	x	x
Topographic moisture		x
Depth to sand (in)		x
Total basal area, live (ft ²)		x
Total basal area, dead (ft ²)		x
Average shrub height (ft)		x
Percent cover, layer (tree, shrub, herbs, fern, graminoid, moss, lichen, litter, bare ground)	x	x
Percent cover, species (trees, shrubs, herbs)	x	x
Site tree data, by species:		
DBH		x
height (ft)		x
age (yr, projected or actual count)	x	
current growth (last 10 yr growth in 20ths of an inch)	x	

Environmental variables on the Recreation Area were sampled more intensively in recon plots than in transect plots, because plot size was so much larger, and physical parameters more varied. Macroposition described position of the plot relative to a large geomorphic feature such as a ridge, with a horizontal axis along the contour line, and a vertical axis between the top and bottom of the slope (vertical). Microposition described position of the plot within about 100 feet, with similar vertical and horizontal axes. Macrorelief described the convexity or concavity of the surface at large, with vertical and horizontal axes, while microrelief did the same for the surface within the boundary of the plot. Topographic moisture identified relative dryness or wetness of the plot, based on whether incident water would tend to pool within the plot, or flow out of it, depending on microtopography. Depth to sand identified the thickness of any organic matter on the surface of the ground. Percent cover was estimated in increments of 1 percent between 0 and 10, and increments of 5 percent between 10 and 100. Total cover for vegetation layers combined estimates of cover for all species in each layer. We sampled three layers -- trees, shrubs and herbs -- from which names of dominant species were chosen. The ground layer was not used to name associations, although total cover of mosses and lichens was recorded. Total cover for the tree layer was estimated separately for mature trees (> 20 ft high) and regenerating trees (< 20 ft high). Total cover for the shrub layer was likewise estimated separately for tall shrubs (> 6 ft high) and low shrubs (< 6 ft high). For site tree data, 1-3 individuals of each species present were measured. Tree height was measured with a range finder and clinometer. Age and current growth were determined by counting increment cores. Basal area was measured with prisms using basal area factors of 20 or 40, depending on density of stems.

Appendix 1. Summary data for recon vegetation plots, continued.

FOREST

Environment	CHLA/VAOV2					
	ALRU/RUSP/CAOB3-LYAM3		PICOC-PSME/MYCA-VAOV2			
	2 Plots		11 Plots		15 Plots	
	MEAN	S.D.	MEAN	S.D.	MEAN	S.D.
Aspect	70	66	30	75	69	39
Slope	2	1	25	25	32	28
Vertical microtopography	2	0	3	1	2	1
Horizontal microtopography	3	1	2	1	3	1
Overstory trees	75	14	64	21	62	16
Understory trees	3	2	5	6	2	3
High shrubs	2	1	82	14	79	24
Low shrubs	2	1	5	8	8	10
Herb	5	7	0	0	1	1
Moss	3	4	27	22	5	5
Bare sand	0	0	0	0	0	1
Species	CON	AVE	CON	AVE	CON	AVE
OVERSTORY TREES						
Madrone	.	.	18	0	.	.
Port Orford cedar	.	.	100	48	.	.
Red alder	100	60	.	.	.	.
Shore pine	.	.	55	5	100	43
Sitka spruce	50	8	73	11	33	1
Douglas fir	.	.	82	10	100	22
Western hemlock	50	2	45	2	20	1
UNDERSTORY TREES						
Port Orford cedar	.	.	73	3	.	.
Scouler willow	.	.	18	3	.	.
Crabapple	50	8	9	Tr	.	.
Sitka spruce	100	1	36	1	33	1
Shore pine	.	.	9	0	33	1
Western hemlock	50	1	36	1	33	0
Douglas fir	.	.	45	1	33	1
Cascara	100	5	18	0	13	0
SHRUBS AND WOODY GROUNDCOVER						
Red elderberry	50	1	.	.	.	.
Douglas spiraea	50	3	.	.	7	Tr
Hairy manzanita	.	.	18	1	33	1
Hooker willow	50	3	.	.	.	.
Black twinberry	100	2	.	.	.	.
Bearberry	.	.	.	.	40	0
Labrador tea	.	.	.	.	7	0
Scots broom	.	.	.	.	60	1
Salmonberry	100	1	.	.	.	.
Trailing blackberry	50	1	9	Tr	.	.
Thimbleberry	50	1	.	.	.	.
Wax myrtle	.	.	82	7	73	7
Evergreen huckleberry	50	0	100	63	100	52
Red huckleberry	50	0	36	1	13	0
Salal	50	1	91	9	100	21
Western rhododendron	.	.	36	8	80	22
Silk tassel	.	.	.	.	7	0
HERBS, FERNS AND GRAMINOID						
Small-fruited bulrush	50	1	.	.	.	.
Lady fern	50	1	.	.	.	.
Clover	.	.	9	Tr	.	.
Slough sedge	100	80	.	.	.	.

Appendix 1. Summary data for recon vegetation plots, continued.

Skunk cabbage	50	2	.	.	.	.
Toothed Australian fireweed	.	.	9	Tr	.	.
Nicotice fern	50	1	27	0	.	.
Red fescue	.	.	.	.	7	Tr
Landystick	.	.	.	.	20	0
Western rattlesnake-plantain	.	.	9	Tr	7	Tr
Sword fern	100	2	27	0	.	.
False lily-of-the-valley	50	2	.	.	20	0
Deer fern	.	.	27	0	.	.
Ground-cone	.	.	9	Tr	40	0
Bracken fern	.	.	64	1	93	4
Snake plant	.	.	9	Tr	7	Tr
Scouler's polypody	.	.	.	.	7	Tr

Environment	PICOC/CAOB3		PISI-PICOC/VAOV2			
	PICOC/CYSC4/AMAR4					
	6 Plots	14 Plots	12 Plots			
	MEAN S.D.	MEAN S.D.	MEAN S.D.			
Aspect	11 39	70 59	27 56			
Slope	0 0	5 6	13 21			
Vertical microtopography	2 1	2 1	3 1			
Horizontal microtopography	2 1	2 1	3 1			
Overstory trees	63 16	26 28	47 30			
Understory trees	1 1	9 12	17 32			
High shrubs	22 18	39 29	61 32			
Low shrubs	6 6	11 18	12 13			
Herb	39 34	34 33	1 1			
Moss	27 35	25 38	21 22			
Bare sand	0 1	4 6	0 1			
Species	CON AVE	CON AVE	CON AVE			
OVERSTORY TREES						
Shore pine	100 63	71 25	83 24			
Sitka spruce	17 1	43 1	83 25			
Douglas fir	.	7 0	25 2			
Western hemlock	.	.	8 0			
Western red cedar	.	.	8 Tr			
UNDERSTORY TREES						
Crabapple	17 0	.	8 0			
Sitka spruce	17 0	64 5	58 5			
Shore pine	50 1	71 4	42 13			
Western hemlock	.	.	8 Tr			
Douglas fir	.	14 0	8 Tr			
Chascara	.	14 Tr	8 0			
Western red cedar	.	.	8 Tr			
SHRUBS AND WOODY GROUNDCOVER						
Douglas spiraea	17 0	.	.			
Hooker willow	50 5	.	8 1			
Black twinberry	50 1	.	8 0			
Bog blueberry	50 2	.	.			
Cultivated cranberry	17 0	.	.			
Bearberry	.	7 1	33 2			
Labrador tea	17 0	7 Tr	8 0			
Scots broom	33 1	100 36	.			
Salmonberry	.	.	8 Tr			
Chaparral broom	.	21 0	.			
Trailing blackberry	.	7 Tr	8 0			
Vax myrtle	83 9	14 2	83 17			
Sitka willow	.	.	8 1			
Evergreen huckleberry	100 6	50 4	100 32			

Appendix 1. Summary data for recon vegetation plots, continued.

Red huckleberry	.	.	.	.	8	Tr
Salal	67	2	29	1	100	25
Western rhododendron	.	.	.	.	17	2
Fool's huckleberry	.	.	7	Tr	.	.
Silk tassel	.	.	.	.	17	1
HERBS, FERNS AND GRAMINOID						
Slough sedge	100	48	.	.	17	0
Toothed Australian fireweed	.	.	14	1	.	.
Tufted hairgrass	33	3	.	.	.	.
Hemlock water-parsnip	17	1	.	.	.	.
Creeping spikerush	17	1	.	.	.	.
Early blue violet	33	0	.	.	.	.
Creeping buttercup	17	0	.	.	.	.
Kings gentian	17	0	.	.	.	.
Western witchgrass	17	0	.	.	.	.
Elegant hairgrass	17	0	.	.	.	.
Spring-bank clover	17	0	.	.	.	.
Northern bugleweed	33	2	.	.	.	.
Marsh speedwell	33	0	.	.	.	.
Hooded ladies-tresses	17	0	.	.	.	.
Sand dune sedge	17	0	.	.	.	.
Western water-milfoil	17	0	.	.	.	.
Nevada rush	17	1	.	.	.	.
Shore sedge	17	0	.	.	.	.
Salt rush	33	2	7	0	.	.
Pacific silverweed	33	4	.	.	8	Tr
California aster	17	0	14	Tr	.	.
Licorice fern	17	0	36	0	8	Tr
Red fescue	.	.	14	0	8	Tr
False dandelion	17	0	71	1	8	Tr
Sticky chickweed	.	.	7	Tr	.	.
Doubtful chickweed	.	.	7	Tr	.	.
Cut-leaved Australian fireweed	.	.	14	0	.	.
Woodland groundsel	.	.	29	0	.	.
Sheep sorrel	.	.	36	0	.	.
Seashore lupine	.	.	14	0	.	.
Green sedge	.	.	7	Tr	.	.
Hairy hawkbit	.	.	7	Tr	.	.
Yarrow	.	.	29	0	.	.
White-flowered hawkweed	.	.	36	0	.	.
Sweet vernal grass	.	.	7	0	.	.
Velvet grass	.	.	21	1	.	.
Silver hairgrass	.	.	43	5	.	.
Six-weeks fescue	.	.	7	1	.	.
Pale montia	.	.	7	Tr	.	.
Coast strawberry	.	.	36	0	.	.
Chickweed	.	.	7	Tr	.	.
Seaside tansy	.	.	7	Tr	.	.
Tansy ragwort	.	.	7	Tr	.	.
Purple cudweed	.	.	7	Tr	.	.
Western rattlesnake-plantain	17	0	.	.	17	Tr
European beachgrass	.	.	100	36	8	1
Little hairgrass	.	.	71	11	17	0
Pearly everlasting	.	.	29	0	.	.
Sword fern	.	.	64	1	17	0
Bird-foot trefoil	.	.	.	.	8	Tr
Bog St. Johnswort	.	.	.	.	8	Tr
Cut-leaved water-horehound	.	.	.	.	8	Tr
Pacific reedgrass	.	.	.	.	8	Tr
Pyrola	.	.	.	.	8	Tr
False lily-of-the-valley	.	.	.	.	33	0
Deer fern	.	.	7	Tr	8	Tr
Bracken fern	.	.	.	.	42	1
Swamp bedstraw	17	0	.	.	.	.
Gnome plant	.	.	.	.	8	Tr

Appendix 1. Summary data for recon vegetation plots, continued.

inome plant	.	.	.	.	8	Tr
icouler's polypody	.	.	.	.	17	0

Environment	PISI/GASH-RUSP					
	PISI/GASH		4 Plots		PISI/VAOV2	
	1 Plots		MEAN	S.D.	14 Plots	
	MEAN	S.D.	MEAN	S.D.	MEAN	S.D.
Aspect	0	0	87	44	15	55
Slope	25	0	6	3	24	27
Vertical microtopography	4	0	3	1	2	1
Horizontal microtopography	1	0	3	1	2	1
Overstory trees	85	0	91	5	57	19
Understory trees	0	0	2	1	4	6
High shrubs	1	0	24	13	82	16
Low shrubs	5	0	15	8	4	3
Herb	1	0	2	1	2	3
Bloss	15	0	40	21	26	21
Bare sand	0	0	0	0	0	1
Species	CON	AVE	CON	AVE	CON	AVE
OVERSTORY TREES						
Red alder	.	.	.	.	7	1
Shore pine	.	.	.	.	36	2
Sitka spruce	100	85	100	81	100	50
Douglas fir	.	.	.	.	43	5
Western hemlock	.	.	100	11	21	1
Western red cedar	.	.	100	10	21	4
UNDERSTORY TREES						
Sitka spruce	.	.	25	0	57	1
Shore pine	.	.	.	.	21	0
Western hemlock	.	.	50	1	21	1
Douglas fir	.	.	.	.	14	Tr
Yasara	100	0	75	9	29	3
Western red cedar	.	.	50	1	7	1
SHRUBS AND WOODY GROUNDCOVER						
Black twinberry	.	.	.	.	29	1
Cots broom	.	.	.	.	7	1
Almonberry	.	.	100	18	7	1
Railing blackberry	.	.	.	.	36	0
Himbleberry	.	.	75	2	.	.
Wax myrtle	.	.	.	.	64	8
Evergreen huckleberry	100	1	100	5	100	54
Red huckleberry	.	.	100	5	.	.
Salal	100	5	100	19	100	26
Western rhododendron	.	.	.	.	43	3
Wool's huckleberry	.	.	75	3	.	.
Wilk tassel	.	.	.	.	36	4
HERBS, FERNS AND GRAMINOIDS						
Clough sedge	.	.	.	.	7	1
Kunk cabbage	.	.	25	1	.	.
Corice fern	.	.	.	.	14	Tr
European beachgrass	.	.	.	.	7	1
Little hairgrass	.	.	.	.	7	Tr
Early everlasting	.	.	.	.	7	Tr
Ward fern	.	.	100	6	21	0
False lily-of-the-valley	.	.	.	.	64	1
Deer fern	.	.	100	9	.	.
Round-cone	.	.	.	.	7	0
Racken fern	.	.	.	.	79	1

Appendix 1. Summary data for recon vegetation plots, continued.

Swamp bedstraw	100	1	25	0	.	.
Evergreen violet	100	1	.	.	.	.
Field woodrush	100	1	.	.	.	.
Candyflower	100	1	25	0	.	.
Fairy lantern	100	0	75	1	.	.
Small-flowered woodrush	.	.	50	0	.	.
Oval-leaved mitrewort	.	.	25	1	.	.
Gnome plant	.	.	25	0	14	Tr
Scouler's polypody	.	.	.	.	7	Tr
Common horsetail	.	.	.	.	7	Tr

PSME/RHMA3-VAOV2

Environment	11 Plots		16 Plots	
	MEAN	S.D.	MEAN	S.D.
Aspect	22	73	52	49
Slope	34	27	37	21
Vertical microtopography	2	1	2	1
Horizontal microtopography	2	1	2	1
Overstory trees	65	17	73	19
Understory trees	1	2	2	3
High shrubs	94	3	83	21
Low shrubs	2	2	7	11
Herb	0	0	2	4
Moss	12	16	22	11
Bare sand	0	1	0	0
Species	CON	AVE	CON	AVE
OVERSTORY TREES				
Red alder	.	.	6	0
Shore pine	73	3	13	0
Sitka spruce	36	3	63	11
Douglas fir	100	60	88	34
Western hemlock	.	.	100	28
Western red cedar	18	3	44	10
UNDERSTORY TREES				
Sitka spruce	9	0	6	Tr
Shore pine	9	0	6	Tr
Western hemlock	.	.	56	1
Douglas fir	36	1	19	1
Cascara	45	1	56	2
Western red cedar	9	0	19	0
SHRUBS AND WOODY GROUNDCOVER				
Scots broom	.	.	6	Tr
Salmonberry	.	.	6	0
Trailing blackberry	9	0	6	Tr
Wax myrtle	82	6	31	2
Evergreen huckleberry	100	67	100	52
Red huckleberry	9	0	56	1
Salal	100	14	100	22
Western rhododendron	91	41	100	39
Silk tassel	36	1	.	.
Ocean spray	36	2	38	1
HERBS, FERNS AND GRAMINOIDS				
Licorice fern	9	Tr	19	0
Candystick	.	.	6	Tr
Western rattlesnake-plantain	9	Tr	.	.
Sword fern	45	1	38	1
False lily-of-the-valley	9	Tr	25	1

Appendix 1. Summary data for recon vegetation plots, continued.

Ground-cone	18	0	25	0
Bracken fern	64	1	69	1
Gnome plant	27	0	19	Tr
Scouler's polypody	9	Tr	31	1
Dwarf mistletoe	.	.	6	Tr
Western trillium	.	.	6	Tr

WOODLAND

Environment	PICOC/ARCO3		PICOC/ARUV	
	5 Plots		11 Plots	
	MEAN	S.D.	MEAN	S.D.
Aspect	245	34	57	69
Slope	23	23	20	29
Vertical microtopography	3	1	3	1
Horizontal microtopography	3	2	3	1
Overstory trees	34	15	38	28
Understory trees	4	4	7	7
High shrubs	70	22	11	10
Low shrubs	16	17	33	22
Herb	0	1	2	3
Moss	13	17	26	24
Bare sand	1	1	5	5
Species	CON	AVE	CON	AVE
OVERSTORY TREES				
Douglas fir	40	3	9	Tr
Shore pine	100	31	91	31
Sitka spruce	.	.	9	Tr
UNDERSTORY TREES				
Douglas fir	40	1	18	Tr
Shore pine	80	3	100	7
Sitka spruce	.	.	18	Tr
Western hemlock	.	.	9	Tr
Cascara	.	.	9	Tr
SHRUBS AND WOODY GROUNDCOVER				
Western rhododendron	80	2	.	.
Evergreen huckleberry	100	36	91	3
Hairy manzanita	100	39	91	5
Salal	100	17	91	2
Wax myrtle	40	5	36	1
Scots broom	40	1	45	4
Bearberry	60	1	100	28
Ocean spray	.	.	9	Tr
HERBS, FERNS AND GRAMINOIDES				
Ground-cone	40	Tr	.	.
Gnome plant	20	Tr	.	.
Pinesap	20	Tr	.	.
Hooded ladies-tresses	20	Tr	9	Tr
Bracken fern	60	1	36	1
Sickle-leaved rush	20	Tr	18	Tr
Silver hairgrass	20	Tr	36	Tr
Seashore lupine	20	Tr	64	1
Candystick	20	Tr	73	1
Little hairgrass	20	Tr	82	1
Slough sedge	.	.	9	Tr
Western rattlesnake-plantain	.	.	9	Tr
Seashore bluegrass	.	.	36	1
Pinedrops	.	.	9	Tr

Appendix 1. Summary data for recon vegetation plots, continued.

Sheep sorrel	.	.	9	Tr
Red fescue	.	.	82	1
Pearly everlasting	.	.	9	Tr
False dandelion	.	.	64	1
European beachgrass	.	.	18	1
Common groundsel	.	.	9	Tr
Salt rush	.	.	27	Tr

SHRUBLAND

Environment	SAHO-MAFU/CAOB3-LYAM3					
	LUAR/AMAR4		2 Plots		SAHO/CAOB3-AREGE	
	MEAN	S.D.	MEAN	S.D.	MEAN	S.D.
Aspect	50	48	0	0	3	15
Slope	5	7	1	0	0	0
Vertical microtopography	4	0	2	0	2	1
Horizontal microtopography	4	0	2	0	2	1
Overstory trees	0	0	3	4	4	9
Understory trees	2	0	0	0	2	8
High shrubs	40	14	63	46	37	31
Low shrubs	18	4	13	4	20	20
Herb	10	0	30	28	71	10
Moss	1	0	12	11	8	16
Bare sand	6	6	0	0	8	11
Species	CON	AVE	CON	AVE	CON	AVE
OVERSTORY TREES						
Red alder	.	.	100	9	.	.
Sitka spruce	.	.	50	2	22	1
Shore pine	.	.	50	2	28	3
UNDERSTORY TREES						
Douglas fir	50	1	.	.	.	.
Shore pine	100	2	.	.	33	2
Sitka spruce	.	.	.	.	17	Tr
Western red cedar	.	.	.	.	6	Tr
SHRUBS AND WOODY GROUNDCOVER						
Chaparral broom	50	1	.	.	.	.
Tree lupine	100	55	.	.	.	.
Scots broom	50	8	.	.	11	Tr
Sitka willow	50	1	50	8	.	.
Black twinberry	50	1	50	1	17	1
Evergreen huckleberry	50	1	100	1	28	1
Wax myrtle	50	1	50	1	39	7
Labrador tea	.	.	100	10	6	Tr
Salal	.	.	100	3	39	3
Hooker willow	50	1	100	55	100	42
Bog blueberry	.	.	.	.	17	1
Trailing blackberry	.	.	.	.	11	Tr
Cultivated cranberry	.	.	.	.	6	Tr
Douglas spiraea	.	.	50	1	6	Tr
HERBS, FERNS AND GRAMINOIDES						
Orchard-grass	50	2	.	.	.	.
Six-weeks fescue	50	1	.	.	.	.
Dogtail	50	1	.	.	.	.
American dunegrass	50	3	.	.	.	.
Pearly everlasting	100	4	.	.	.	.
Sheep sorrel	100	1	.	.	.	.
Perennial sow-thistle	50	1	.	.	.	.

Appendix 1. Summary data for recon vegetation plots, continued.

arentucellia	50	1	.	.	.	.
each knotweed	50	1	.	.	.	.
ut-leaved Australian fireweed	50	Tr	.	.	.	.
eachore lupine	50	3	.	.	.	.
uropean beachgrass	100	40	.	.	.	.
arrow	50	3	.	.	.	.
ilver hairgrass	100	2	.	.	.	.
oast strawberry	100	3	.	.	.	.
entgrass	50	1	.	.	.	.
elvet grass	100	1	.	.	6	Tr
alse dandelion	100	3	.	.	17	Tr
ittle hairgrass	100	2	50	1	.	.
icorice fern	50	1	100	2	.	.
word fern	50	2	100	1	6	Tr
kunk cabbage	.	.	100	28	.	.
usick's sedge	.	.	50	1	.	.
alt rush	50	1	.	.	50	2
itka sedge	.	.	50	23	.	.
eer fern	.	.	100	1	.	.
ird-foot trefoil	50	1	.	.	61	5
arsh cinquefoil	.	.	50	2	11	Tr
og St. Johnswort	.	.	50	1	33	2
oothed Australian fireweed	50	2	50	1	11	Tr
acific silverweed	.	.	.	.	94	23
uropean centaury	.	.	.	.	6	Tr
hite-flowered hawkweed	.	.	.	.	17	Tr
orthern bugleweed	.	.	.	.	33	2
lough sedge	.	.	100	40	100	50
ufted hairgrass	.	.	.	.	6	Tr
atson's willow-herb	.	.	.	.	11	Tr
ed fescue	.	.	.	.	6	1
ilaeopsis	.	.	.	.	11	1
ound-leaved sundew	.	.	.	.	11	Tr
alifornia aster	.	.	.	.	44	1
ickle-leaved rush	.	.	.	.	39	1
arsh speedwell	.	.	.	.	67	1
ady fern	.	.	100	2	.	.
hore sedge	.	.	.	.	17	1
loating-leaved pondweed	.	.	.	.	6	Tr
iant helleborine	.	.	.	.	33	Tr
weet vernal grass	.	.	.	.	6	Tr
olden-eyed grass	.	.	.	.	39	1
og clubmoss	.	.	.	.	11	Tr
ings gentian	.	.	.	.	11	1
hree-square bulrush	.	.	.	.	6	Tr
evada rush	.	.	.	.	39	4
yrola	.	.	.	.	11	Tr
pring-bank clover	.	.	.	.	44	1
implestem bur-reed	.	.	.	.	6	Tr
aintbrush orthocarpus	.	.	.	.	6	Tr
reen sedge	.	.	.	.	33	1
reeping buttercup	.	.	.	.	50	1
wamp bedstraw	.	.	.	.	28	Tr
ooded ladies-tresses	.	.	.	.	6	Tr
orsetail	.	.	.	.	11	Tr
apered rush	.	.	.	.	6	Tr
oad rush	.	.	.	.	6	Tr
reeping spikerush	.	.	.	.	17	Tr

Appendix 1. Summary data for recon vegetation plots, continued.

Environment	SPDO	
	1 Plots	
	MEAN	S.D.
Aspect	200	0
Slope	0	0
Vertical microtopography	2	0
Horizontal microtopography	2	0
Overstory trees	0	0
Understory trees	0	0
High shrubs	50	0
Low shrubs	10	0
Herb	10	0
Moss	0	0
Bare sand	0	0
Species	CON	AVE
OVERSTORY TREES		
None		
UNDERSTORY TREES		
None		
SHRUBS AND WOODY GROUNDCOVER		
Hooker willow	100	2
Douglas spiraea	100	60
HERBS, FERNS AND GRAMINOIDS		
Toothed Australian fireweed	100	10
Slough sedge	100	20
Lady fern	100	2
Hardstem bulrush	100	3

DWARF-SHRUBLAND

Environment	VAUL/CAOB3		VAUL/DECEC	
	10 Plots		3 Plots	
	MEAN	S.D.	MEAN	S.D.
Aspect	0	0	20	68
Slope	0	0	0	0
Vertical microtopography	2	1	3	1
Horizontal microtopography	2	1	3	1
Overstory trees	2	6	0	0
Understory trees	3	5	0	0
High shrubs	20	25	2	3
Low shrubs	59	26	15	26
Herb	37	33	12	11
Moss	11	17	0	0
Bare sand	0	1	0	0
Species	CON	AVE	CON	AVE
OVERSTORY TREES				
Shore pine	20	2	33	2
UNDERSTORY TREES				
Sitka spruce	10	Tr	.	.
Shore pine	70	2	33	Tr

Appendix 1. Summary data for recon vegetation plots, continued.

rabapple	40	1	33	1
ascara	.	.	33	Tr

SHRUBS AND WOODY GROUNDCOVER

abrador tea	50	1	.	.
cots broom	10	Tr	.	.
vergreen huckleberry	40	1	.	.
ed huckleberry	10	Tr	.	.
ultivated cranberry	30	17	.	.
og blueberry	100	54	33	13
alal	50	1	33	Tr
ooker willow	90	13	67	2
ouglas spiraea	30	2	33	2
ax myrtle	30	2	33	Tr

HERBS, FERNS AND GRAMINOIDS

ut-leaved water-horehound	20	Tr	.	.
ickle-leaved rush	20	Tr	.	.
lue-eyed grass	10	Tr	.	.
oastline bluegrass	10	Tr	.	.
ings gentian	20	Tr	.	.
ird-foot trefoil	10	1	.	.
eal-all	20	1	.	.
oad rush	10	1	.	.
iant helleborine	10	Tr	.	.
arly blue violet	30	Tr	.	.
eamshore lupine	10	Tr	.	.
ivid sedge	10	1	.	.
eatery grape-fern	10	Tr	.	.
estern witchgrass	10	Tr	.	.
hite-flowered hawkweed	10	Tr	.	.
alifornia aster	40	2	.	.
pring-bank clover	30	Tr	.	.
acific reedgrass	20	Tr	.	.
orthern bugleweed	40	1	.	.
onkey flower	10	Tr	.	.
reeping spikerush	10	Tr	.	.
and dune sedge	20	Tr	.	.
olden-eyed grass	10	Tr	.	.
alt rush	60	2	33	Tr
reeping buttercup	50	Tr	33	2
marsh speedwell	90	2	67	1
acific silverweed	80	9	67	1
lough sedge	100	27	100	7
alse dandelion	30	1	33	Tr
evada rush	10	1	33	1
ufted hairgrass	10	Tr	100	38
merican wintercress	.	.	33	Tr
ommon horsetail	.	.	33	Tr
estern water-hemlock	.	.	33	Tr
urly dock	.	.	33	Tr
oothed Australian fireweed	.	.	67	2
word fern	.	.	33	Tr
nflated sedge	.	.	33	1
owland cudweed	.	.	33	Tr
ommon bladderwort	.	.	33	1
orthern bedstraw	.	.	33	Tr
atson's willow-herb	.	.	33	Tr
arrow	.	.	33	Tr
og St. Johnswort	.	.	33	1
early everlasting	.	.	33	Tr
ield mint	.	.	67	Tr
ater smartweed	.	.	33	1
ster	.	.	33	1
ommon witchgrass	.	.	33	Tr

Appendix 1. Summary data for recon vegetation plots, continued.

HERBACEOUS VEGETATION

Environment	AGSTS-AREGE		AMAR4		CALY3-AREGE	
	1 Plots		16 Plots		4 Plots	
	MEAN	S.D.	MEAN	S.D.	MEAN	S.D.
Aspect	0	0	4	45	0	0
Slope	0	0	2	4	0	1
Vertical microtopography	2	0	2	2	2	0
Horizontal microtopography	2	0	3	2	2	0
Overstory trees	0	0	0	0	0	0
Understory trees	0	0	1	1	0	0
High shrubs	0	0	2	4	0	0
Low shrubs	0	0	3	6	0	0
Herb	70	0	37	37	35	45
Moss	0	0	0	1	0	0
Bare sand	1	0	26	34	6	13
Species	CON	AVE	CON	AVE	CON	AVE
OVERSTORY TREES						
Sitka spruce	.	.	6	Tr	.	.
UNDERSTORY TREES						
Sitka spruce	.	.	19	Tr	.	.
Shore pine	.	.	31	Tr	.	.
SHRUBS AND WOODY GROUNDCOVER						
Chaparral broom	.	.	6	Tr	.	.
Tree lupine	.	.	6	Tr	.	.
Black twinberry	.	.	6	Tr	.	.
Bearberry	.	.	13	1	.	.
Wax myrtle	.	.	13	1	.	.
Salal	.	.	19	Tr	.	.
Scots broom	.	.	31	1	.	.
Evergreen huckleberry	.	.	6	Tr	.	.
Hooker willow	.	.	13	1	.	.
HERBS, FERNS AND GRAMINOIDS						
Licorice fern	.	.	6	Tr	.	.
Sword fern	.	.	13	Tr	.	.
Dogtail	.	.	6	Tr	.	.
Deer fern	.	.	6	Tr	.	.
Ripgut brome	.	.	6	Tr	.	.
Seaside dock	.	.	.	.	25	1
Mayweed chamomile	.	.	.	.	25	Tr
Fleshy jaumea	.	.	.	.	25	Tr
American wintercress	.	.	.	.	25	Tr
Leathery grape-fern	.	.	13	Tr	.	.
Pond water-starwort	.	.	.	.	25	Tr
Toothed Australian fireweed	.	.	19	Tr	.	.
Seaside plantain	.	.	.	.	25	Tr
Seaside arrowgrass	.	.	.	.	25	Tr
Shadscale	.	.	.	.	25	1
Hemlock water-parsnip	.	.	.	.	.	.
Skunk cabbage	.	.	.	.	.	.
Tall mannagrass	.	.	.	.	.	.
Tufted hairgrass	100	1	.	.	75	8
Creeping bentgrass	100	30	.	.	25	Tr
Lyngby sedge	100	2	.	.	100	68
Sea pea	.	.	25	8	.	.
American dunegrass	.	.	31	4	.	.
Meadow barley	.	.	.	.	25	1
Saltgrass	100	4	.	.	75	4

Appendix 1. Summary data for recon vegetation plots, continued.

arrow	.	.	38	Tr	.	.
bumweed	100	1	.	.	.	.
colonial bentgrass	.	.	.	.	25	5
curly dock	.	.	.	.	.	.
early everlasting	.	.	69	1	.	.
salt rush	100	3	31	2	50	1
oodland groundsel	.	.	25	Tr	.	.
seaside tansy	.	.	19	Tr	.	.
spring-bank clover	.	.	13	Tr	50	3
hite-flowered hawkweed	.	.	38	Tr	.	.
evada rush	.	.	6	Tr	25	Tr
sticky chickweed	.	.	13	Tr	.	.
six-weeks fescue	.	.	19	Tr	.	.
alifornia aster	.	.	6	Tr	.	.
lough sedge	100	1	13	1	25	1
alse dandelion	.	.	81	2	.	.
ickle-leaved rush	.	.	6	Tr	.	.
elvet grass	.	.	6	Tr	.	.
ilver hairgrass	.	.	50	1	.	.
heep sorrel	.	.	25	Tr	.	.
warf orthocarpus	.	.	6	Tr	.	.
and dune sedge	.	.	6	Tr	.	.
otton-batting plant	.	.	6	Tr	.	.
aintbrush orthocarpus	.	.	.	.	25	Tr
acific silverweed	100	70	.	.	100	15
atson's willow-herb	.	.	6	Tr	.	.
ittle hairgrass	.	.	50	2	.	.
oast strawberry	.	.	56	2	.	.
uropean beachgrass	.	.	100	51	.	.
ed fescue	.	.	31	1	25	Tr
olden-eyed grass	.	.	6	Tr	.	.
uropean centaury	.	.	13	Tr	.	.
each knotweed	.	.	13	Tr	.	.
hree-square bulrush	.	.	.	.	50	2
urple cudweed	.	.	13	Tr	.	.
arsh speedwell	.	.	6	Tr	.	.
ird-foot trefoil	.	.	6	Tr	.	.
each lupine	.	.	69	2	.	.
each bluegrass	.	.	13	1	.	.
each silvertop	.	.	6	Tr	.	.
reeping spikerush	.	.	.	.	50	1
arsh cinquefoil	.	.	6	Tr	.	.

Environment	CAOB3		CAOB3-AREGE		CAEX5	
	1 Plots		15 Plots		3 Plots	
	MEAN	S.D.	MEAN	S.D.	MEAN	S.D.
spect	200	0	0	30	0	0
lope	0	0	0	0	0	0
ertical microtopography	2	0	3	1	2	1
orizontal microtopography	2	0	3	1	2	1
erstory trees	0	0	1	1	0	0
nderstory trees	0	0	5	15	0	0
igh shrubs	0	0	6	9	0	0
ow shrubs	0	0	6	18	0	0
erb	5	0	69	31	38	50
oss	0	0	4	9	0	0
are sand	0	0	6	9	0	0
Species	CON	AVE	CON	AVE	CON	AVE
OVERSTORY TREES						
hore pine	.	.	27	Tr	.	.

Appendix 1. Summary data for recon vegetation plots, continued.

UNDERSTORY TREES

Sitka spruce	.	.	20	Tr	.	.
Shore pine	.	.	40	1	.	.

SHRUBS AND WOODY GROUNDCOVER

Chaparral broom	.	.	7	Tr	.	.
Tree lupine	.	.	7	Tr	.	.
Wax myrtle	.	.	33	1	.	.
Salal	.	.	27	3	.	.
Scots broom	.	.	13	Tr	.	.
Evergreen huckleberry	.	.	20	Tr	.	.
Hooker willow	.	.	87	4	33	Tr
Douglas spiraea	.	.	.	.	67	1
Bog blueberry	.	.	13	Tr	.	.

HERBS, FERNS AND GRAMINOID

Leathery grape-fern	.	.	13	Tr	.	.
Pond water-starwort	100	1	.	.	.	.
Northern bedstraw	100	1	.	.	.	.
Toothed Australian fireweed	100	2	13	Tr	.	.
Field mint	100	1	.	.	33	Tr
Adders-tongue	.	.	7	Tr	.	.
Bractless hedge-hyssop	.	.	7	Tr	.	.
Speedwell	.	.	7	Tr	.	.
Western witchgrass	.	.	13	Tr	.	.
Heal-all	.	.	7	Tr	.	.
Whorled water-pennywort	.	.	7	Tr	.	.
Swamp bedstraw	.	.	20	Tr	.	.
Buttercup	.	.	7	Tr	.	.
Hemlock water-parsnip	.	.	.	.	33	Tr
Skunk cabbage	.	.	.	.	33	Tr
Tall mannagrass	.	.	.	.	33	2
Reed canary grass	.	.	7	Tr	.	.
American dunegrass	.	.	7	Tr	.	.
Yarrow	.	.	20	Tr	.	.
Curly dock	.	.	7	Tr	.	.
Sea watch	.	.	7	Tr	.	.
Kings gentian	.	.	13	1	.	.
Salt rush	.	.	60	2	.	.
Seaside tansy	.	.	7	Tr	.	.
Spring-bank clover	.	.	53	1	.	.
White-flowered hawkweed	.	.	13	Tr	.	.
Creeping buttercup	.	.	60	4	.	.
Nevada rush	.	.	33	2	.	.
Early blue violet	.	.	7	Tr	.	.
Meadow fescue	.	.	.	.	.	.
Six-weeks fescue	.	.	7	Tr	.	.
California aster	.	.	53	1	.	.
Slough sedge	100	90	100	55	100	3
False dandelion	.	.	40	Tr	.	.
Sickle-leaved rush	.	.	60	5	.	.
Velvet grass	.	.	7	Tr	.	.
Silver hairgrass	.	.	7	Tr	.	.
Green sedge	.	.	20	1	.	.
Northern bugleweed	.	.	20	3	.	.
Pacific silverweed	.	.	93	25	.	.
Watson's willow-herb	.	.	20	Tr	.	.
Little hairgrass	.	.	13	Tr	.	.
Shore sedge	.	.	20	1	33	Tr
Seaside lotus	.	.	20	1	.	.
Coast strawberry	.	.	7	Tr	.	.
European beachgrass	.	.	7	Tr	.	.
Pyrola	.	.	7	Tr	.	.
Bog St. Johnswort	.	.	13	2	.	.
Water smartweed	100	1	.	.	.	.
Red fescue	.	.	7	Tr	.	.

Appendix 1. Summary data for recon vegetation plots, continued.

Golden-eyed grass	.	.	13	Tr	.	.
Hardstem bulrush	100	1	.	.	.	.
Giant helleborine	.	.	7	Tr	.	.
European centaury	.	.	13	Tr	.	.
Alaëopsis	.	.	33	1	.	.
Flooded ladies-tresses	.	.	7	Tr	.	.
Purple cudweed	.	.	7	Tr	.	.
Northern mannagrass	.	.	.	.	67	1
Inflated sedge	.	.	.	.	67	48
Marsh speedwell	.	.	53	1	100	1
Bird-foot trefoil	.	.	20	3	.	.
Hairy hawkbit	.	.	7	Tr	.	.
Pond lily	.	.	.	.	100	9
Parentucellia	.	.	7	Tr	.	.
Creeping spikerush	.	.	27	3	33	2
Floating-leaved pondweed	.	.	.	.	33	Tr
Blue-eyed grass	.	.	7	Tr	.	.

Environment	DISP-AREGE		LEMOM2		ELPA3-JUNE	
	6 Plots		4 Plots		11 Plots	
	MEAN	S.D.	MEAN	S.D.	MEAN	S.D.
Aspect	0	0	3	57	3	36
Slope	0	1	15	29	0	0
Vertical microtopography	2	0	1	1	2	1
Horizontal microtopography	2	0	1	1	2	1
Overstory trees	0	0	0	0	0	0
Understory trees	0	0	0	0	0	0
High shrubs	0	0	1	1	0	1
Low shrubs	0	0	1	1	4	7
Herb	47	44	67	46	68	26
Foss	0	0	0	0	8	19
Bare sand	6	8	5	10	13	18
Species	CON	AVE	CON	AVE	CON	AVE
OVERSTORY TREES						
None						
UNDERSTORY TREES						
Oregon ash	.	.	25	Tr	.	.
SHRUBS AND WOODY GROUNDCOVER						
Black twinberry	.	.	50	1	.	.
Trailing blackberry	.	.	25	Tr	.	.
Salmonberry	.	.	25	1	.	.
Wax myrtle	.	.	.	.	9	Tr
Salal	.	.	.	.	9	Tr
Hooker willow	.	.	.	.	73	3
Labrador tea	.	.	.	.	9	Tr
Douglas spiraea	.	.	25	Tr	9	Tr
HERBS, FERNS AND GRAMINOIDS						
Toothed Australian fireweed	.	.	25	1	.	.
Seaside plantain	.	.	.	.	9	Tr
Seaside arrowgrass	17	Tr	.	.	9	Tr
Shadscale	50	1	.	.	.	.
Fall mannagrass	.	.	.	.	9	Tr
Tufted hairgrass	33	1	50	1	.	.
Creeping bentgrass	17	1	.	.	9	Tr
Sea milkwort	17	3	.	.	.	.
Lyngby sedge	83	12	.	.	9	Tr
Sea pea	.	.	100	31	.	.

Appendix 1. Summary data for recon vegetation plots, continued.

Reed canary grass	.	.	.	.	9	Tr
American dunegrass	.	.	100	69	.	.
Meadow barley	17	Tr	25	Tr	.	.
Saltgrass	100	73	.	.	18	Tr
Brass buttons	17	Tr	.	.	9	Tr
Graceful arrowgrass	17	Tr	.	.	9	Tr
Yarrow	.	.	75	1	.	.
Gumweed	.	.	25	Tr	.	.
Canada thistle	.	.	25	Tr	.	.
Bittersweet nightshade	.	.	25	Tr	.	.
Searocket	.	.	25	Tr	.	.
Common groundsel	.	.	25	Tr	.	.
Tansy ragwort	.	.	25	3	.	.
Coastline bluegrass	.	.	25	Tr	.	.
Colonial bentgrass	33	1	50	3	9	Tr
Curly dock	.	.	50	1	.	.
Pearly everlasting	.	.	25	Tr	.	.
Sea watch	.	.	25	1	.	.
Salt rush	50	1	75	5	64	2
Different-leaved water-starwort	.	.	.	.	9	Tr
Tapered rush	.	.	.	.	18	2
Common cattail	.	.	.	.	9	2
Common horsetail	.	.	.	.	9	Tr
Toad rush	.	.	.	.	9	Tr
Mexican plantain	.	.	.	.	9	Tr
Parrot feather	.	.	.	.	9	Tr
Spring-bank clover	50	1	.	.	18	Tr
Creeping buttercup	17	1	.	.	64	9
Nevada rush	17	Tr	.	.	82	22
Dune bentgrass	.	.	.	.	9	Tr
Meadow fescue	.	.	25	Tr	.	.
California aster	.	.	25	Tr	27	Tr
Slough sedge	17	1	.	.	73	3
Rush	17	Tr	.	.	.	.
False dandelion	.	.	25	Tr	9	Tr
Low clubrush	.	.	.	.	18	Tr
English plantain	.	.	25	Tr	.	.
Sickle-leaved rush	.	.	.	.	55	8
Velvet grass	.	.	50	2	9	Tr
Sheep sorrel	.	.	25	1	.	.
Green sedge	.	.	.	.	27	Tr
Northern bugleweed	.	.	.	.	9	Tr
Pacific silverweed	100	12	50	11	82	3
Watson's willow-herb	.	.	.	.	9	Tr
Shore sedge	.	.	.	.	73	11
Baltic rush	33	3	.	.	.	.
Coast strawberry	.	.	.	.	9	Tr
European beachgrass	.	.	50	7	.	.
Bog St. Johnswort	.	.	.	.	9	4
Water smartweed	.	.	.	.	9	Tr
Red fescue	.	.	50	1	9	Tr
Golden-eyed grass	.	.	.	.	27	Tr
Giant helleborine	.	.	.	.	9	Tr
Pickleweed	17	1	.	.	.	.
Round-leaved sundew	.	.	.	.	9	Tr
Lilaeopsis	17	3	.	.	91	14
Hooded ladies-tresses	.	.	.	.	9	Tr
Three-square bulrush	50	8	.	.	27	3
Marsh speedwell	.	.	.	.	18	Tr
Bird-foot trefoil	.	.	25	1	18	1
Procumbent pearlwort	.	.	.	.	18	Tr
Parentucellia	.	.	.	.	9	Tr
Creeping spikerush	33	1	.	.	91	29

Appendix 1. Summary data for recon vegetation plots, continued.

Environment	FERU2		FERU2-JULE		FERU2-PTAQ	
	9 Plots		6 Plots		3 Plots	
	MEAN	S.D.	MEAN	S.D.	MEAN	S.D.
spect	34	62	0	0	243	27
lope	10	11	0	0	49	19
ertical microtopography	3	1	2	1	2	1
orizontal microtopography	3	2	2	1	2	1
verstory trees	0	0	0	0	0	0
nderstory trees	1	1	1	1	5	7
igh shrubs	0	0	0	0	0	0
ow shrubs	0	1	4	6	3	4
erb	10	12	71	28	8	10
oss	5	15	1	1	0	0
are sand	65	26	9	13	60	21
pecies	CON	AVE	CON	AVE	CON	AVE
OVERSTORY TREES						
one						
UNDERSTORY TREES						
Douglas fir	11	Tr	.	.	.	.
Sitka spruce	.	.	33	Tr	.	.
Shore pine	44	1	33	Tr	67	4
Aspen	.	.	17	Tr	.	.
SHRUBS AND WOODY GROUNDCOVER						
Marberry	33	Tr	17	Tr	33	2
Box myrtle	.	.	67	1	.	.
Salal	.	.	67	3	.	.
Cots broom	.	.	50	1	33	Tr
Evergreen huckleberry	.	.	50	1	.	.
Hooker willow	.	.	33	1	.	.
HERBS, FERNS AND GRAMINOIDS						
Tufted hairgrass	.	.	50	7	.	.
Reeping bentgrass	.	.	17	3	.	.
Sea pea	.	.	17	Tr	.	.
American dunegrass	.	.	33	Tr	.	.
Meadow barley	.	.	33	1	.	.
Altgrass	.	.	17	2	.	.
Arrow	22	1	33	2	.	.
Sumweed	.	.	50	5	.	.
Colonial bentgrass	.	.	17	1	.	.
Curly dock	.	.	17	Tr	.	.
Early everlasting	44	Tr	17	Tr	.	.
Sea watch	.	.	17	Tr	.	.
Alt rush	11	Tr	100	10	.	.
Seaside tansy	.	.	17	Tr	.	.
Spring-bank clover	.	.	50	1	.	.
Reeping buttercup	.	.	17	Tr	.	.
Evada rush	.	.	50	8	.	.
Ticky chickweed	.	.	17	Tr	.	.
Seaside tansy	11	Tr	.	.	.	.
Sea pea	11	Tr	.	.	.	.
Dune bentgrass	11	1	17	Tr	.	.
Nine-weeks fescue	.	.	17	1	.	.
California aster	.	.	50	1	.	.
Slough sedge	.	.	50	1	.	.
False dandelion	67	1	83	4	33	1
English plantain	.	.	50	1	.	.
Tickle-leaved rush	.	.	33	3	.	.
Velvet grass	.	.	50	6	.	.

Appendix 1. Summary data for recon vegetation plots, continued.

Silver hairgrass	11	Tr	50	1	.	.
Sheep sorrel	.	.	50	2	33	Tr
Roughstalk bluegrass	.	.	17	4	.	.
Bluejoint reedgrass	.	.	17	Tr	.	.
Dwarf orthocarpus	.	.	33	Tr	.	.
Sand dune sedge	.	.	17	7	.	.
Green sedge	.	.	17	Tr	.	.
Paintbrush orthocarpus	.	.	33	Tr	.	.
Pacific silverweed	.	.	50	1	.	.
Little hairgrass	22	1	67	4	.	.
Seaside lotus	.	.	33	2	.	.
Coast strawberry	44	Tr	50	2	.	.
European beachgrass	11	Tr	.	.	.	.
Bog St. Johnswort	.	.	17	Tr	.	.
Red fescue	100	18	100	23	100	6
Golden-eyed grass	.	.	17	Tr	.	.
Bracken fern	.	.	.	.	100	25
Giant helleborine	.	.	17	Tr	.	.
European centaury	.	.	67	1	.	.
Beach knotweed	89	1	33	Tr	33	Tr
Round-leaved sundew	.	.	17	Tr	.	.
Purple cudweed	.	.	33	Tr	.	.
Bird-foot trefoil	.	.	17	1	.	.
Procumbent pearlwort	.	.	33	1	.	.
Seashore lupine	44	5	33	4	67	15
Bog clubmoss	.	.	17	Tr	.	.
Hairy hawkbit	11	Tr	.	.	.	.
Sweet vernal grass	.	.	17	3	.	.
Seashore bluegrass	67	3	.	.	100	1
Beach silvertop	56	1	.	.	67	1
Parentucellia	.	.	33	1	.	.

Environment	JUBA-AREGE		JUFA-JULE		JULE	
	1 Plots		10 Plots		7 Plots	
	MEAN	S.D.	MEAN	S.D.	MEAN	S.D.
Aspect	0	0	3	35	9	29
Slope	1	0	0	0	0	0
Vertical microtopography	2	0	2	1	2	1
Horizontal microtopography	2	0	2	1	2	1
Overstory trees	0	0	0	0	3	5
Understory trees	0	0	2	3	2	2
High shrubs	0	0	9	16	2	2
Low shrubs	0	0	22	22	5	7
Herb	60	0	55	26	69	21
Moss	0	0	7	12	1	1
Bare sand	0	0	9	14	19	21
Species	CON	AVE	CON	AVE	CON	AVE
OVERSTORY TREES						
Shore pine	.	.	10	Tr	57	3
UNDERSTORY TREES						
Sitka spruce	.	.	20	Tr	29	Tr
Shore pine	.	.	70	2	71	2
SHRUBS AND WOODY GROUNDCOVER						
Wax myrtle	.	.	40	4	14	Tr
Salal	.	.	50	2	29	Tr
Scots broom	.	.	20	Tr	71	2
Evergreen huckleberry	.	.	50	1	14	Tr
Hooker willow	.	.	100	20	57	3

Appendix 1. Summary data for recon vegetation plots, continued.

Labrador tea	.	.	20	2	14	Tr
Red elderberry	.	.	10	Tr	.	.
Silk tassel	.	.	.	.	14	1
HERBS, FERNS AND GRAMINOIDES						
Tufted hairgrass	100	1	.	.	.	.
Creeping bentgrass	100	5	.	.	.	.
Lynby sedge	100	2	.	.	.	.
Saltgrass	100	25	.	.	.	.
Yarrow	.	.	.	.	14	Tr
Gumweed	100	1	.	.	.	.
Colonial bentgrass	.	.	.	.	14	1
Pearly everlasting	.	.	10	Tr	14	Tr
Kings gentian	.	.	10	Tr	.	.
Salt rush	.	.	90	12	100	12
Seaside tansy	.	.	10	Tr	14	Tr
Spring-bank clover	.	.	40	4	14	Tr
White-flowered hawkweed	.	.	20	Tr	14	Tr
Creeping buttercup	.	.	50	3	14	Tr
Nevada rush	.	.	50	5	29	6
Sticky chickweed	.	.	.	.	14	Tr
Early blue violet	.	.	10	Tr	.	.
Meadow fescue	.	.	.	.	14	Tr
Six-weeks fescue	.	.	.	.	43	6
California aster	.	.	60	1	57	1
Slough sedge	.	.	90	4	86	7
Rush	.	.	.	.	14	5
False dandelion	.	.	100	2	100	9
Low clubrush	.	.	10	Tr	.	.
English plantain	.	.	.	.	14	Tr
Sickle-leaved rush	.	.	100	23	43	Tr
Velvet grass	.	.	20	Tr	43	4
Silver hairgrass	.	.	.	.	57	4
Sheep sorrel	.	.	10	Tr	57	1
Dwarf orthocarpus	.	.	.	.	14	Tr
Sand dune sedge	.	.	.	.	14	Tr
Cotton-batting plant	.	.	.	.	14	Tr
Green sedge	.	.	60	1	.	.
Northern bugleweed	.	.	30	1	14	Tr
Paintbrush orthocarpus	.	.	40	1	29	1
Pacific silverweed	100	60	70	3	14	1
Watson's willow-herb	.	.	40	1	29	Tr
Little hairgrass	.	.	30	1	86	11
Shore sedge	.	.	50	1	14	Tr
Baltic rush	100	40	.	.	.	.
Seaside lotus	.	.	20	4	29	4
Coast strawberry	.	.	50	1	57	1
European beachgrass	.	.	10	Tr	43	3
Pyrola	.	.	20	Tr	.	.
Bog St. Johnswort	.	.	40	2	14	Tr
Red fescue	.	.	20	Tr	43	1
Golden-eyed grass	.	.	80	2	29	Tr
Giant helleborine	.	.	50	1	.	.
Pickleweed	100	1	.	.	.	.
European centaury	.	.	60	1	71	2
Round-leaved sundew	.	.	30	1	.	.
Lilaeopsis	.	.	30	1	.	.
Hooded ladies-tresses	.	.	30	Tr	14	Tr
Purple cudweed	.	.	40	1	71	2
Marsh speedwell	.	.	40	1	29	Tr
Bird-foot trefoil	.	.	40	5	43	1
Procumbent pearlwort	.	.	20	1	43	1
Seashore lupine	.	.	20	1	71	6
Bog clubmoss	.	.	30	1	.	.
Tall fescue	100	1	.	.	.	.
Hairy hawkbit	.	.	30	1	.	.

Appendix 1. Summary data for recon vegetation plots, continued.

Sweet vernal grass	.	.	20	Tr	29	2
Parentucellia	.	.	40	1	29	Tr
Monkey flower	.	.	20	Tr	14	Tr
Creeping spikerush	.	.	20	1	.	.
Field chickweed	.	.	.	.	14	Tr
Elegant hairgrass	.	.	.	.	14	Tr
Fescue	.	.	.	.	14	2
Bromegrass	.	.	.	.	29	3
Little quaking-grass	.	.	.	.	29	1
Marsh cinquefoil	.	.	10	Tr	.	.

Environment	LULI2		NULUP		POMA26	
	4 Plots		1 Plots		1 Plots	
	MEAN	S.D.	MEAN	S.D.	MEAN	S.D.
Aspect	38	55	0	0	0	0
Slope	24	25	0	0	0	0
Vertical microtopography	3	1	2	0	2	0
Horizontal microtopography	4	1	2	0	2	0
Overstory trees	0	0	0	0	0	0
Understory trees	0	0	0	0	1	0
High shrubs	0	0	0	0	0	0
Low shrubs	0	0	1	0	0	0
Herb	41	35	20	0	1	0
Moss	0	0	0	0	0	0
Bare sand	54	42	0	0	90	0
Species	CON	AVE	CON	AVE	CON	AVE
OVERSTORY TREES						
None						
UNDERSTORY TREES						
None						
SHRUBS AND WOODY GROUNDCOVER						
Douglas spiraea	.	.	100	1	.	.
HERBS, FERNS AND GRAMINOID						
Pearly everlasting	25	Tr	.	.	.	.
Woodland groundsel	25	Tr	.	.	.	.
White-flowered hawkweed	25	Tr	.	.	.	.
Slough sedge	.	.	100	1	.	.
False dandelion	50	3	.	.	.	.
Silver hairgrass	50	1	.	.	.	.
Little hairgrass	50	Tr	.	.	.	.
Coast strawberry	25	Tr	.	.	.	.
European beachgrass	100	10	.	.	100	3
Red fescue	75	2	.	.	100	1
Beach knotweed	25	Tr	.	.	.	.
Northern mannagrass	.	.	100	2	.	.
Inflated sedge	.	.	100	2	.	.
Marsh speedwell	.	.	100	1	.	.
Seashore lupine	100	31	.	.	100	1
Hairy hawkbit	25	Tr	.	.	.	.
Seashore bluegrass	100	6	.	.	100	15
Beach silvertop	50	1	.	.	100	1
Pond lily	.	.	100	20	.	.
Creeping spikerush	.	.	100	1	.	.
Fowl bluegrass	25	1	.	.	.	.
Yellow abronia	25	Tr	.	.	.	.
Floating-leaved pondweed	.	.	100	1	.	.
Threeway sedge	.	.	100	2	.	.

Appendix 1. Summary data for recon vegetation plots, continued.

Knotweed	.	.	100	1	.	.
Water clubrush	.	.	100	5	.	.
Marsh cinquefoil	.	.	100	1	.	.

Environment	PONA4		SCACA		SCAM6	
	1 Plots		1 Plots		3 Plots	
	MEAN	S.D.	MEAN	S.D.	MEAN	S.D.
Aspect	0	0	200	0	0	0
Slope	0	0	0	0	0	0
Vertical microtopography	3	0	2	0	1	1
Horizontal microtopography	3	0	2	0	1	1
Overstory trees	0	0	0	0	0	0
Understory trees	0	0	0	0	0	0
High shrubs	0	0	0	0	0	0
Low shrubs	0	0	0	0	2	2
Herb	80	0	15	0	63	54
Moss	0	0	0	0	0	0
Bare sand	20	0	0	0	28	41

Species	CON	AVE	CON	AVE	CON	AVE
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OVERSTORY TREES

None

UNDERSTORY TREES

None

SHRUBS AND WOODY GROUNDCOVER

Hooker willow	.	.	.	.	67	2
Douglas spiraea	.	.	100	1	.	.
Bog blueberry	.	.	100	1	.	.

HERBS, FERNS AND GRAMINOID

Lyngby sedge	.	.	.	.	33	5
Saltgrass	.	.	.	.	33	1
Salt rush	.	.	.	.	33	Tr
Spring-bank clover	.	.	.	.	33	1
Slough sedge	.	.	.	.	67	15
Pacific silverweed	100	1	.	.	100	10
Shore sedge	.	.	.	.	33	Tr
Coast strawberry	.	.	.	.	33	Tr
Water smartweed	.	.	100	15	.	.
Hardstem bulrush	.	.	100	60	.	.
Beach knotweed	.	.	.	.	33	1
Lilaeopsis	.	.	.	.	67	2
Three-square bulrush	.	.	.	.	100	45
Marsh speedwell	100	1	.	.	.	.
Bird-foot trefoil	.	.	.	.	33	1
Pond lily	.	.	100	2	.	.
Parentucellia	.	.	.	.	33	Tr
Creeping spikerush	100	5	.	.	100	12
Floating-leaved pondweed	100	60	.	.	.	.
Blue-eyed grass	.	.	.	.	33	1
Horsetail	100	2	.	.	.	.
Marsh cinquefoil	.	.	.	.	33	3
Simplestem bur-reed	100	35	.	.	.	.

Appendix 1. Summary data for recon vegetation plots, continued.

Environment	SPAN2	
	1 Plots	
	MEAN	S.D.
Aspect	0	0
Slope	0	0
Vertical microtopography	2	0
Horizontal microtopography	2	0
Overstory trees	0	0
Understory trees	0	0
High shrubs	5	0
Low shrubs	5	0
Herb	10	0
Moss	0	0
Bare sand	0	0
Species	CON	AVE
OVERSTORY TREES		
None		
UNDERSTORY TREES		
None		
SHRUBS AND WOODY GROUNDCOVER		
None		
HERBS, FERNS AND GRAMINOID		
Slough sedge	100	10
Pacific silverweed	100	1
Creeping spikerush	100	1
Marsh cinquefoil	100	1
Simplestem bur-reed	100	45

Appendix 2. Summary data for transect vegetation plots, Oregon Dunes National Recreation Area, by National Vegetation Classification System class and association. Minimum constancy = 0.10, minimum average cover = 0.10, Tr = < 1.0.

HERBACEOUS VEGETATION

Environment	AMAR4		LEMOM2		ELPA3-JUNE	
	80 Plots		1 Plots		30 Plots	
	MEAN	S.D.	MEAN	S.D.	MEAN	S.D.
Microposition	10	8	16	0	11	8
Moss	6	5	.	.	.	.
Bare sand	41	30	70	0	89	5
Lichen	10	15	.	.	.	.
Litter	19	23	.	.	6	6
Species	CON	AVE	CON	AVE	CON	AVE
OVERSTORY TREES						
Shore pine	4	Tr	.	.	.	.
SHRUBS AND WOODY GROUNDCOVER						
Tree lupine	8	5	.	.	.	.
Wax myrtle	1	Tr	.	.	.	.
Hooker willow	1	Tr	.	.	7	Tr
Salal	6	Tr	.	.	.	.
Evergreen huckleberry	1	Tr	.	.	.	.
HERBS, FERNS AND GRAMINOIDS						
Woodland groundsel	1	Tr	.	.	.	.
Toothed Australian fireweed	11	1	.	.	.	.
American dunegrass	8	Tr	100	30	.	.
Silver hairgrass	5	Tr	.	.	.	.
European beachgrass	100	18	.	.	.	.
Lilaeopsis	.	.	.	.	10	Tr
Creeping spikerush	.	.	.	.	100	11
Shore sedge	.	.	.	.	37	1
Pearly everlasting	35	2	.	.	.	.
Pacific silverweed	1	Tr	.	.	43	1
California aster	19	1	.	.	.	.
Coast strawberry	45	3	.	.	.	.
Paintbrush orthocarpus	1	Tr	.	.	.	.
Slough sedge	6	Tr	.	.	7	1
Nevada rush	5	Tr	.	.	67	8
Yarrow	13	Tr	.	.	.	.
Doubtful chickweed	1	Tr	.	.	.	.
False dandelion	48	2	.	.	.	.
Watson's willow-herb	1	Tr	.	.	.	.
Sheep sorrel	20	Tr	.	.	.	.
Red fescue	5	Tr	.	.	.	.
Spring-bank clover	3	Tr	.	.	.	.
Bird-foot trefoil	.	.	.	.	10	Tr
Parentucellia	1	Tr	.	.	.	.
Elegant hairgrass	3	Tr	.	.	.	.
Monkey flower	1	Tr	.	.	.	.
Seaside lotus	3	Tr	.	.	.	.
Toad rush	3	Tr	.	.	.	.
Sickle-leaved rush	1	Tr	.	.	.	.
Little hairgrass	29	3	.	.	.	.
Purple cudweed	4	Tr	.	.	.	.
Salt rush	20	1	.	.	.	.
Beach knotweed	1	Tr	.	.	.	.
Dune bentgrass	1	Tr	.	.	.	.
European centaury	6	Tr	.	.	.	.
Seaside tansy	1	Tr	.	.	.	.

Appendix 2. Summary data for transect vegetation plots, continued.

Hairy hawkbit	3	Tr	.	.	.	.
Seashore lupine	33	5	.	.	.	.
	FERU2		JUFA-JULE		JULE	
	8 Plots		29 Plots		29 Plots	
Environment	MEAN	S.D.	MEAN	S.D.	MEAN	S.D.
Microposition	27	9	10	8	11	8
Moss	.	.	.	.	27	30
Bare sand	91	5	46	32	42	37
Lichen	.	.	3	0	10	11
Litter	2	1	11	11	16	14
Species	CON	AVE	CON	AVE	CON	AVE
OVERSTORY TREES						
None						
SHRUBS AND WOODY GROUNDCOVER						
Wax myrtle	.	.	.	.	3	Tr
Hooker willow	.	.	69	6	3	Tr
Salal	.	.	.	.	21	3
Evergreen huckleberry	.	.	3	Tr	17	1
Scots broom	.	.	10	Tr	14	2
HERBS, FERNS AND GRAMINOIDS						
European beachgrass	.	.	7	Tr	17	1
Shore sedge	.	.	3	Tr	.	.
Pearly everlasting	.	.	3	Tr	10	Tr
Pacific silverweed	13	Tr	7	Tr	.	.
California aster	.	.	21	Tr	10	Tr
Coast strawberry	.	.	14	Tr	45	1
Paintbrush orthocarpus	.	.	7	Tr	.	.
Slough sedge	.	.	17	1	7	1
Nevada rush	.	.	79	3	17	Tr
Yarrow	.	.	.	.	21	Tr
Doubtful chickweed	.	.	.	.	3	Tr
False dandelion	.	.	55	1	59	4
Watson's willow-herb	.	.	17	Tr	3	Tr
Sheep sorrel	.	.	7	Tr	52	1
Red fescue	100	7	7	Tr	10	1
Bractless hedge-hyssop	.	.	10	Tr	.	.
Green sedge	.	.	10	Tr	.	.
Creeping buttercup	.	.	31	Tr	.	.
Golden-eyed grass	.	.	31	Tr	.	.
Bog St. Johnswort	.	.	10	Tr	.	.
Giant helleborine	.	.	10	Tr	.	.
Hooded ladies-tresses	.	.	10	Tr	.	.
Sand dune sedge	.	.	7	Tr	.	.
Spring-bank clover	.	.	14	Tr	10	Tr
Bird-foot trefoil	.	.	45	5	.	.
Parentucellia	.	.	31	1	7	Tr
Elegant hairgrass	.	.	3	Tr	3	Tr
Monkey flower	.	.	10	Tr	7	Tr
Seaside lotus	.	.	17	2	14	Tr
Toad rush	.	.	10	Tr	14	Tr
Procumbent pearlwort	.	.	34	Tr	3	Tr
Sickle-leaved rush	.	.	83	3	14	Tr
Little hairgrass	.	.	34	1	59	9
Purple cudweed	.	.	34	Tr	28	1
Salt rush	13	Tr	83	2	86	12
Beach knotweed	13	Tr	.	.	3	Tr
Dune bentgrass	13	Tr	41	1	7	Tr

Appendix 2. Summary data for transect vegetation plots, continued.

European centaury	.	.	38	Tr	34	1
Seaside tansy	.	.	3	Tr	.	.
Airy hawkbit	13	Tr	55	4	38	1
Seashore lupine	25	1	34	7	48	1
Elvet grass	.	.	.	.	3	Tr
Sweet vernal grass	.	.	.	.	3	Tr
Nine-weeks fescue	.	.	.	.	14	Tr
Each silvertop	25	Tr	.	.	3	Tr
Warf orthocarpus	.	.	.	.	3	Tr
Seashore bluegrass	38	1	.	.	.	.

Environment	LULI2		POMA26	
	54 Plots		20 Plots	
	MEAN	S.D.	MEAN	S.D.
Microposition	11	8	16	9
Soil	14	18	.	.
Are sand	50	33	88	6
Lichen	3	0	.	.
Litter	14	19	3	2
Species	CON	AVE	CON	AVE
OVERSTORY TREES				
Shore pine	4	1	.	.
Sitka spruce	2	Tr	.	.
SHRUBS AND WOODY GROUNDCOVER				
Cooker willow	4	Tr	.	.
Salal	2	Tr	.	.
HERBS, FERNS AND GRAMINOIDS				
Silver hairgrass	2	Tr	.	.
European beachgrass	33	2	.	.
Early everlasting	17	1	.	.
Pacific silverweed	.	.	10	Tr
California aster	7	Tr	.	.
Coast strawberry	22	1	.	.
Tough sedge	4	Tr	.	.
Evada rush	15	Tr	.	.
Arrow	6	Tr	.	.
Alse dandelion	57	1	.	.
Heep sorrel	11	Tr	.	.
Red fescue	35	2	10	Tr
Bird-foot trefoil	11	Tr	.	.
Legant hairgrass	4	Tr	.	.
Procumbent pearlwort	2	Tr	.	.
Tickle-leaved rush	7	Tr	.	.
Little hairgrass	56	3	.	.
Purple cudweed	6	Tr	.	.
Alt rush	44	2	.	.
Each knotweed	13	Tr	.	.
Une bentgrass	28	1	.	.
European centaury	22	Tr	.	.
Seaside tansy	6	Tr	.	.
Airy hawkbit	44	1	.	.
Seashore lupine	100	25	35	Tr
Each silvertop	7	Tr	30	Tr
Warf orthocarpus	2	Tr	.	.
Seashore bluegrass	2	Tr	100	10

Appendix 3. Checklist of vascular plants of the Oregon Dunes National Recreation Area.

This list was compiled by numerous contributors, especially David Danley, Katie Grenier, Sheila Logan, Dan Segotta, Shelly Smith, John Christy, and Jimmy Kagan. Nomenclature follows the PLANTS database (USDA, NRCS 1997).

TREES

PLANTS code

<i>Alnus rubra</i>	Red alder	ALRU
<i>Arbutus menziesii</i>	Madrone	ARME
<i>Chamaecyparis lawsoniana</i>	Port Orford cedar	CHLA
<i>Fraxinus latifolia</i>	Oregon ash	FRLA
<i>Picea sitchensis</i>	Sitka spruce	PISI
<i>Pinus attenuata</i>	Knobcone pine	PIAT
<i>Pinus contorta</i>	Shore pine	PICO
<i>Pinus nigra</i>	Black pine	PINI
<i>Pinus pinaster</i>	Cluster pine	PIPI6
<i>Pinus radiata</i>	Monterey pine	PIRA2
<i>Pinus sylvestris</i>	Scots pine	PISY
<i>Pseudotsuga menziesii</i>	Douglas fir	PSME
<i>Sequoia sempervirens</i>	Coast redwood	SESE3
<i>Thuja plicata</i>	Western red cedar	THPL
<i>Tsuga heterophylla</i>	Western hemlock	TSHE

SHRUBS AND WOODY VINES

<i>Acer circinatum</i>	Vine maple	ACCI
<i>Arceuthobium</i> sp.	Dwarf mistletoe	ARCEU
<i>Arctostaphylos columbiana</i>	Hairy manzanita	ARCO3
<i>Arctostaphylos uva-ursi</i>	Bearberry, kinnikinnik	ARUV
<i>Baccharis pilularis</i>	Chaparral broom	BAPI
<i>Crataegus douglasii</i>	Black hawthorn	CRDO2
<i>Cytisus scoparius</i>	Scots broom	CYSC4
<i>Cytisus striatus</i>	Broom	CYST7
<i>Frangula purshiana</i>	Cascara	FRPU7
<i>Garrya elliptica</i>	Silk tassel	GAEL
<i>Gaultheria shallon</i>	Salal	GASH
<i>Hedera helix</i>	English ivy	HEHE
<i>Holodiscus discolor</i>	Ocean spray	HODI
<i>Ilex aquifolium</i>	English holly	ILAQ80
<i>Ledum glandulosum</i>	Labrador tea	LEGL
<i>Lonicera involucrata</i>	Black twinberry	LOIN5
<i>Lupinus arboreus</i>	Tree lupine	LUAR
<i>Malus fusca</i>	Crabapple	MAFU
<i>Menziesia ferruginea</i>	Fool's huckleberry	MEFE
<i>Myrica californica</i>	Wax myrtle	MYCA
<i>Prunus virginiana</i>	Chokecherry	PRVI
<i>Rhododendron macrophyllum</i>	Western rhododendron	RHMA3
<i>Ribes sanguineum</i>	Red flowering currant	RISA
<i>Rosa gymnocarpa</i>	Baldhip rose	ROGY
<i>Rubus discolor</i>	Himalayan blackberry	RUDI2
<i>Rubus laciniatus</i>	Evergreen blackberry	RULA
<i>Rubus parviflorus</i>	Thimbleberry	RUPA
<i>Rubus spectabilis</i>	Salmonberry	RUSP

Appendix 3. Checklist of vascular plants, continued.

<i>Rubus ursinus</i>	Trailing blackberry	RUUR
<i>Salix hookeriana</i>	Coast willow	SAHO
<i>Salix scouleriana</i>	Scouler willow	SASC
<i>Salix sitchensis</i>	Sitka willow	SASI2
<i>Ambucus racemosa</i> ssp. <i>pubens</i> var. <i>arborescens</i>	Red elderberry	SARAA
<i>Spiraea douglasii</i>	Douglas spiraea	SPDO
<i>Ulex europaeus</i>	Gorse	ULEU
<i>Vaccinium macrocarpon</i>	Eastern cranberry	VAMA
<i>Vaccinium ovatum</i>	Evergreen huckleberry	VAOV2
<i>Vaccinium oxycoccos</i>	Wild cranberry	VAOX
<i>Vaccinium parvifolium</i>	Red huckleberry	VAPA
<i>Vaccinium uliginosum</i>	Bog blueberry	VAUL

FERNS AND CLUBMOSSES

<i>Adiantum filix-femina</i>	Lady fern	ATFI
<i>Asplenium mexicanum</i>	Mexican water-fern	AZME
<i>Polypodium spicatum</i>	Deer fern	BLSP
<i>Polypodium multifidum</i>	Leathery grape-fern	BOMU
<i>Equisetum arvense</i>	Common horsetail	EQAR
<i>Polypodium nuttallii</i>	Nuttall's quillwort	ISNU
<i>Polypodiella inundata</i>	Bog clubmoss	LYIN2
<i>Phlogossum vulgatum</i>	Adders-tongue	OPVU
<i>Polypodium glycyrrhiza</i>	Licorice fern	POGL8
<i>Polypodium scouleri</i>	Scouler's polypody	POSC4
<i>Polystichum munitum</i>	Sword fern	POMU
<i>Pteridium aquilinum</i>	Bracken fern	PTAQ

GRASSES

<i>Deschampsia capillaris</i>	Colonial bentgrass	AGCA5
<i>Deschampsia pallens</i>	Dune bentgrass	AGPA8
<i>Deschampsia stolonifera</i>	Creeping bentgrass	AGSTS
<i>Poa caryophylla</i>	Silver hairgrass	AICA
<i>Poa elegans</i>	Elegant hairgrass	AIEL4
<i>Poa praecox</i>	Little hairgrass	AIPR
<i>Ammophila arenaria</i>	European beachgrass	AMAR4
<i>Anthoxanthum odoratum</i>	Sweet vernal grass	ANOD
<i>Briza minor</i>	Little quaking-grass	BRMI2
<i>Bromus diandrus</i>	Ripgut brome	BRDI3
<i>Bromus hordeaceus</i>	Soft brome	BRHOH
<i>Calamagrostis canadensis</i>	Bluejoint reedgrass	CACAC10
<i>Calamagrostis nutkaensis</i>	Pacific reedgrass	CANU
<i>Cynosurus echinatus</i>	Dogtail	CYEC
<i>Dactylis glomerata</i>	Orchard-grass	DAGL
<i>Deschampsia cespitosa</i> ssp. <i>cespitosa</i>	Tufted hairgrass	DECEC
<i>Dichanthelium acuminatum</i> var. <i>fasciculatum</i>	Western witchgrass	DIACF
<i>Distichlis spicata</i>	Saltgrass	DISP
<i>Festuca rubra</i>	Red fescue	FERU2
<i>Glyceria borealis</i>	Northern mannagrass	GLBO
<i>Glyceria elata</i>	Tall mannagrass	GLEL
<i>Iolcus lanatus</i>	Velvet grass	HOLA
<i>Lordeum brachyantherum</i>	Meadow barley	HOBR2

Appendix 3. Checklist of vascular plants, continued.

<i>Leymus mollis</i>	American dunegrass	LEMOM2
<i>Lolium arundinaceum</i>	Tall fescue	LOAR10
<i>Panicum capillare</i>	Common witchgrass	PACA6
<i>Paspalum distichum</i>	Knotgrass	PADI6
<i>Phalaris arundinacea</i>	Reed canary grass	PHAR3
<i>Poa annua</i>	Annual bluegrass	POAN
<i>Poa confinis</i>	Coastline bluegrass	POCO2
<i>Poa trivialis</i>	Roughstalk bluegrass	POTR2
<i>Poa macrantha</i>	Seashore bluegrass	POMA26
<i>Poa pratensis</i>	Kentucky bluegrass	POPR
<i>Torreyochloa pallida</i> var. <i>pauciflora</i>	Alkaligrass	TOPAP3
<i>Vulpia bromoides</i>	Six-weeks fescue	VUBR

SEDGES, SPIKERUSHES AND BULRUSHES

<i>Bolboschoenus maritimus</i>	Seacoast bulrush	BOMA7
<i>Carex aquatilis</i> var. <i>dives</i>	Sitka sedge	CAAQD
<i>Carex cusickii</i>	Cusick's sedge	CACU5
<i>Carex exsiccata</i>	Inflated sedge	CAEX5
<i>Carex lenticularis</i>	Shore sedge	CALE8
<i>Carex livida</i>	Livid sedge	CALI
<i>Carex lyngbyei</i>	Lyngby sedge	CALY3
<i>Carex macrocephala</i>	Large-headed sedge	CAMA10
<i>Carex obnupta</i>	Slough sedge	CAOB3
<i>Carex pansa</i>	Sand dune sedge	CAPA16
<i>Carex viridula</i> ssp. <i>viridula</i>	Green sedge	CAVIV
<i>Dulichium arundinaceum</i>	Threeway sedge	DUAR3
<i>Eleocharis acicularis</i>	Needle sedge	ELAC
<i>Eleocharis palustris</i>	Creeping spikerush	ELPA3
<i>Schoenoplectus acutus</i> var. <i>acutus</i>	Hardstem bulrush	SCACA
<i>Schoenoplectus americanus</i>	Three-square bulrush	SCAM6
<i>Schoenoplectus subterminalis</i>	Water clubrush	SCSU10
<i>Scirpus cernuus</i>	Low clubrush	SCCE
<i>Scirpus microcarpus</i>	Small-fruited bulrush	SCMI2

RUSHES AND WOODRUSHES

<i>Juncus acuminatus</i>	Tapered rush	JUAC
<i>Juncus balticus</i>	Baltic rush	JUBA
<i>Juncus bufonius</i>	Toad rush	JUBU
<i>Juncus ensifolius</i>	Dagger-leaved rush	JUEN
<i>Juncus falcatus</i>	Sickle-leaved rush	JUFA
<i>Juncus lesueurii</i>	Salt rush	JULE
<i>Juncus nevadensis</i>	Nevada rush	JUNE
<i>Luzula campestris</i>	Field woodrush	LUCA2
<i>Luzula parviflora</i>	Small-flowered woodrush	LUPA4

HERBS

<i>Abronia latifolia</i>	Yellow sandverbena	ABLA2
<i>Abronia umbellata</i> ssp. <i>breviflora</i>	Pink sandverbena	ABUMB
<i>Achillea millefolium</i>	Yarrow	ACMI2

Appendix 3. Checklist of vascular plants, continued.

<i>Lotropa virgata</i>	Candystick	ALVI2
<i>Nebrosia chamissonis</i>	Silver burweed	AMCH4
<i>Tagallis minima</i>	Chaffweed	ANMI4
<i>Lophalis margaritacea</i>	Pearly everlasting	ANMA
<i>Argemone lucida</i>	Sea watch	ANLU
<i>Thlaspi cotula</i>	Mayweed chamomile	ANCO2
<i>Quilegia formosa</i>	Red columbine	AQFO
<i>Thlaspi egedii</i>	Pacific silverweed	AREGE
<i>Thlaspi chilensis</i>	California aster	ASCH2
<i>Thlaspi patula</i>	Shadscale	ATPA4
<i>Thlaspi orthoceras</i>	American wintercress	BAOR
<i>Thlaspi cernua</i>	Nodding beggars-tick	BICE
<i>Thlaspi schreberi</i>	Water-shield	BRSC
<i>Thlaspi hookeri</i>	Ground-cone	BOHO
<i>Thlaspi edentula</i>	American searocket	CAED
<i>Thlaspi maritima</i>	European searocket	CAMA
<i>Thlaspi heterophylla</i>	Different-leaved water-starwort	CAHE3
<i>Thlaspi stagnalis</i>	Pond water-starwort	CAST
<i>Thlaspi contorta</i>	Beach evening-primrose	CACO34
<i>Thlaspi ramosissimum</i>	Sand mat	CARA3
<i>Thlaspi ambigua</i> ssp. <i>ambigua</i>	Paintbrush orthocarpus	CAAMA3
<i>Thlaspi erythraea</i>	European centaury	CEER5
<i>Thlaspi arvense</i>	Field chickweed	CEAR4
<i>Thlaspi dubium</i>	Doubtful chickweed	CEDU2
<i>Thlaspi glomeratum</i>	Sticky chickweed	CEGL2
<i>Thlaspi douglasii</i>	Western water-hemlock	CIDO
<i>Thlaspi arvense</i>	Canada thistle	CIAR4
<i>Thlaspi sibirica</i> var. <i>sibirica</i>	Candyflower	CLSI5
<i>Thlaspi spathulata</i>	Pale montia	CLSP10
<i>Thlaspi palustre</i>	Marsh cinquefoil	COPA28
<i>Thlaspi maculatum</i>	Poison hemlock	COMAP
<i>Thlaspi maritimum</i> ssp. <i>palustris</i>	Salt-marsh bird's-beak	COMA
<i>Thlaspi coronopifolia</i>	Brass buttons	COCO7
<i>Thlaspi salina</i>	Salt-marsh dodder	CUSA
<i>Thlaspi carota</i>	Wild carrot	DACA6
<i>Thlaspi smithii</i>	Fairy lantern	DISM2
<i>Thlaspi rotundifolia</i>	Round-leaved sundew	DRRO
<i>Thlaspi densa</i>	South American waterweed	EGDE
<i>Thlaspi angustifolium</i>	Fireweed	EPAN2
<i>Thlaspi ciliatum</i> ssp. <i>watsonii</i>	Watson's willow-herb	EPCIW
<i>Thlaspi gigantea</i>	Giant helleborine	EPGI
<i>Thlaspi glaucus</i>	Seaside daisy	ERGL3
<i>Thlaspi glomerata</i>	Cut-leaved Australian fireweed	ERGL8
<i>Thlaspi minima</i>	Toothed Australian fireweed	ERMI6
<i>Thlaspi chiloensis</i>	Coast strawberry	FRCH
<i>Thlaspi boreale</i>	Northern bedstraw	GABO2
<i>Thlaspi trifidum</i>	Swamp bedstraw	GATR2
<i>Thlaspi purpurea</i>	Purple cudweed	GAPU3
<i>Thlaspi sceptrum</i>	Kings gentian	GESC
<i>Thlaspi maritima</i>	Sea milkwort	GLMA
<i>Thlaspi littoralis</i> ssp. <i>leiocarpa</i>	Beach silver-top	GLLIL
<i>Thlaspi palustre</i>	Lowland cudweed	GNPA
<i>Thlaspi oblongifolia</i>	Western rattlesnake-plantain	GOOB2
<i>Thlaspi ebracteata</i>	Bractless hedge-hyssop	GREB
<i>Thlaspi stricta</i> var. <i>stricta</i>	Gumweed	GRSTS2

Appendix 3. Checklist of vascular plants, continued.

<i>Hemitomes congestum</i>	Gnome-plant	HECO6
<i>Hieracium albiflorum</i>	White-flowered hawkweed	HIAL2
<i>Hippuris vulgaris</i>	Common mare's-tail	HIVU2
<i>Honckenya peploides</i>	Sea purslane	HOPE
<i>Hydrocotyle ranunculoides</i>	Floating water-pennywort	HYRA
<i>Hydrocotyle verticillata</i>	Whorled water-pennywort	HYVE2
<i>Hypericum anagalloides</i>	Bog St. Johnswort	HYAN2
<i>Hypochaeris radicata</i>	False dandelion	HYRA3
<i>Iris pseudacorus</i>	Yellow iris	IRPS
<i>Iris tenax</i>	Oregon iris	IRTE
<i>Jaumea carnosa</i>	Fleshy jaumea	JACA4
<i>Lathyrus japonicus</i>	Sea pea	LAJA
<i>Lathyrus littoralis</i>	Beach pea	LALI2
<i>Lemna minor</i>	Duckweed	LEMI3
<i>Leontodon hirtus</i>	Hairy hawkbit	LEHI4
<i>Leucanthemum vulgare</i>	Oxe-eye daisy	LEVU
<i>Lilaeopsis occidentalis</i>	Lilaeopsis	LIOC
<i>Lotus corniculatus</i>	Bird-foot trefoil	LOCO6
<i>Lotus formosissimus</i>	Seaside lotus	LOFO2
<i>Ludwigia palustris</i>	Water purslane	LUPA
<i>Lupinus littoralis</i>	Seashore lupine	LULI2
<i>Lupinus rivularis</i>	Streambank lupine	LURI
<i>Lycopus americanus</i>	Bugleweed	LYAM
<i>Lysichiton americanum</i>	Skunk cabbage	LYAM3
<i>Lythrum salicaria</i>	Purple loosestrife	LYSA2
<i>Maianthemum dilatatum</i>	False lily-of-the-valley	MADI
<i>Melilotus alba</i>	White sweet-clover	MEAL12
<i>Mentha arvensis</i>	Field mint	MEAR4
<i>Mentha pulegium</i>	Pennyroyal	MEPU
<i>Menyanthes trifoliata</i>	Bog buckbean	METR3
<i>Mimulus guttatus</i>	Monkey flower	MIGU
<i>Mitella ovalis</i>	Oval-leaved mitrewort	MIOV
<i>Monotropa hypopithys</i>	Pinesap	MOHY3
<i>Monotropa uniflora</i>	Indian pipe	MOUN3
<i>Myriophyllum aquaticum</i>	Parrot-feather	MYAQ2
<i>Myriophyllum hippuroides</i>	Western water-milfoil	MYHI
<i>Najas flexilis</i>	Wavy water-nymph	NAFL
<i>Nuphar lutea</i> ssp. <i>polysepala</i>	Pond lily	NULUP
<i>Nymphaea odorata</i>	American water-lily	NYOD
<i>Oenanthe sarmentosa</i>	Water-parsley	OESA
<i>Parentucellia viscosa</i>	Parentucellia	PAVI3
<i>Plantago australis</i> ssp. <i>hirtella</i>	Mexican plantain	PLAUH
<i>Plantago lanceolata</i>	English plantain	PLLA
<i>Plantago major</i>	Common plantain	PLMA2
<i>Plantago maritima</i>	Seaside plantain	PLMA3
<i>Polygonum amphibium</i>	Water smartweed	POAM8
<i>Polygonum hydropiperoides</i>	Waterpepper	POHY2
<i>Polygonum paronychia</i>	Beach knotweed	POPA7
<i>Potamogeton natans</i>	Floating-leaved pondweed	PONA4
<i>Prunella vulgaris</i>	Heal-all	PRVU
<i>Pseudognaphalium stramineum</i>	Cotton-batting plant	PSST7
<i>Pterospora andromedea</i>	Pinedrops	PTAN2
<i>Pyrola asarifolia</i>	Pyrola	PYAS
<i>Ranunculus flammula</i>	Creeping buttercup	RAFL2
<i>Ranunculus repens</i>	Creeping buttercup	RARE3

Appendix 3. Checklist of vascular plants, continued.

<i>Minunculus uncinatus</i> var. <i>parviflorus</i>	Little buttercup	RAUNP
<i>Oxalis acetosella</i>	Sheep sorrel	RUAC3
<i>Oxalis crispus</i>	Curly dock	RUCR
<i>Oxalis maritimus</i>	Seaside dock	RUMA4
<i>Paspalum maritima</i>	Ditch-grass	RUMA5
<i>Pinguicula procumbens</i>	Procumbent pearlwort	SAPR
<i>Polygala virginica</i>	Pickleweed	SAVI
<i>Ranunculus jacobea</i>	Tansy ragwort	SEJA
<i>Ranunculus sylvaticus</i>	Woodland groundsel	SESY
<i>Ranunculus vulgaris</i>	Common groundsel	SEVU
<i>Syrinchium angustifolium</i>	Blue-eyed grass	SIAN3
<i>Syrinchium californicum</i>	Golden-eyed grass	SICA8
<i>Urtica suave</i>	Hemlock water-parsnip	SISU2
<i>Urtica dulcamara</i>	Bittersweet nightshade	SODU
<i>Urtica simplex</i> ssp. <i>simplex</i> var. <i>spathulata</i>	Sticky goldenrod	SOSIS4
<i>Urtica arvensis</i>	Perennial sow-thistle	SOAR2
<i>Urtica angustifolium</i>	Simplestem bur-reed	SPAN2
<i>Urtica salina</i> var. <i>salina</i>	Saltmarsh sandspurry	SPSAS
<i>Urtica romanzoffiana</i>	Hooded ladies-tresses	SPRO
<i>Urtica polyrhiza</i>	Great duckweed	SPP08
<i>Urtica</i> sp.	Chickweed	STELL
<i>Urtica camphoratum</i>	Seaside tansy	TACA2
<i>Urtica microcephalum</i>	Small-head clover	TRMI4
<i>Urtica wormskjoldii</i>	Spring-bank clover	TRWO2
<i>Urtica concinnum</i>	Graceful arrowgrass	TRCO4
<i>Urtica maritimum</i>	Seaside arrowgrass	TRMA4
<i>Urtica striatum</i>	Three-ribbed arrowgrass	TRST6
<i>Urtica ovatum</i>	Western trillium	TROV2
<i>Urtica pusilla</i>	Dwarf orchocarpus	TRPU16
<i>Urtica latifolia</i>	Common cattail	TYLA
<i>Urtica gibba</i>	Humped bladderwort	UTGI
<i>Urtica macrorrhiza</i>	Common bladderwort	UTMA
<i>Urtica minor</i>	Lesser bladderwort	UTMI
<i>Urtica scutellata</i>	Marsh speedwell	VESC2
<i>Urtica americana</i>	American vetch	VIAM
<i>Urtica nigricans</i> ssp. <i>gigantea</i>	Giant vetch	VINIG
<i>Urtica adunca</i>	Early blue violet	VIAD
<i>Urtica palustris</i>	Marsh violet	VIPA4
<i>Urtica sempervirens</i>	Evergreen violet	VISE3
<i>Urtica japonica</i>	Dwarf eel-grass	ZOJA2

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